Lecture 18

Photolithography:

Designing of Mask

Aligner System

Hi welcome, to this particular module and this is the, second module for the lecture mask aligner. Right?

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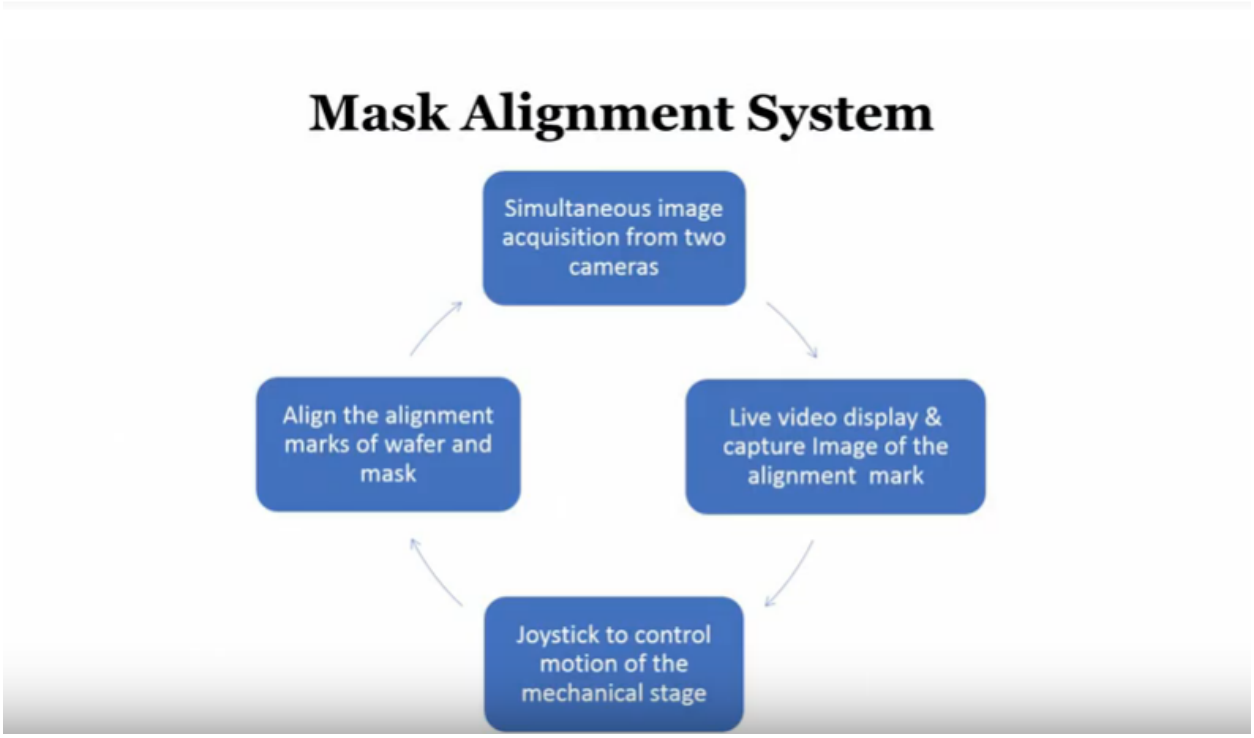

So, if you recall, in the mask align an alignment system, what we have discussed? We have discussed that, we need a few stages, first is of course the joystick to move your X Y and theta stage or mechanical stage, there is align, we need to align the alignment marks, of wafer and mask, we need to simultaneously acquire the image, from two cameras or a spirit-filled camera we can use, we need to have a live-video display or an capture, capture the image of the alignment mark, these are the setups that are required for arraignment 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, with a workshop, from 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, the system that we, are designing here, is a one mask process. But, we are planning to integrate and we, 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's say, did let me give an example, so that it is, easy. So, if you see this hard drive. Right? This is Lenovo. Al 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? So, this is what we have seen in the videos, when we were looking at the lithography system, front to back alignment, using MJ before. So, the, the mask aligner that we are. Right? Now discussing, is only front aligner, it cannot do front to back arrangement. But, with front alignment also we can do, we can fabricate lot of devices. Al 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, you use a, basic programming languages and C, C++ 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, if you see the, see the slide

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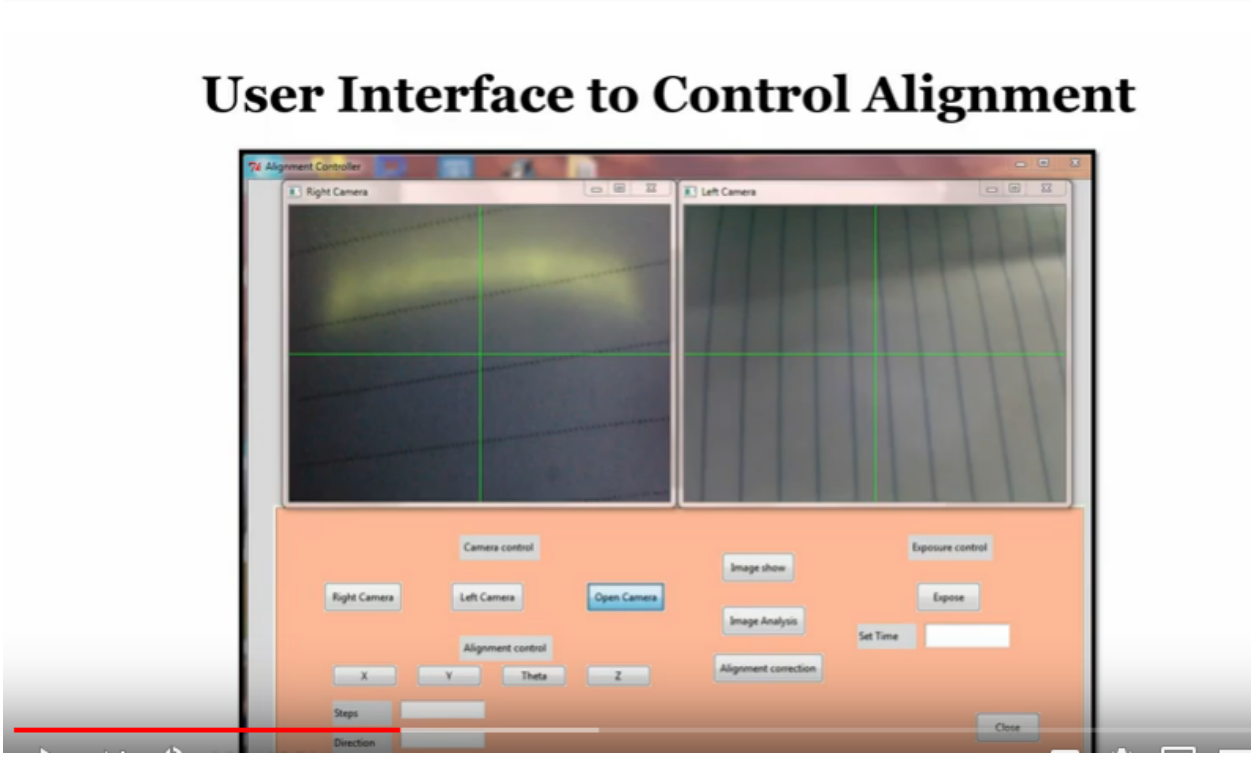

This is what it should, look like. Right? Of course depends on the user, depends on you how you want, to create your control alignment interface. But if you see here, our Right? And left camera can see simultaneously. So, how this camera comes into picture

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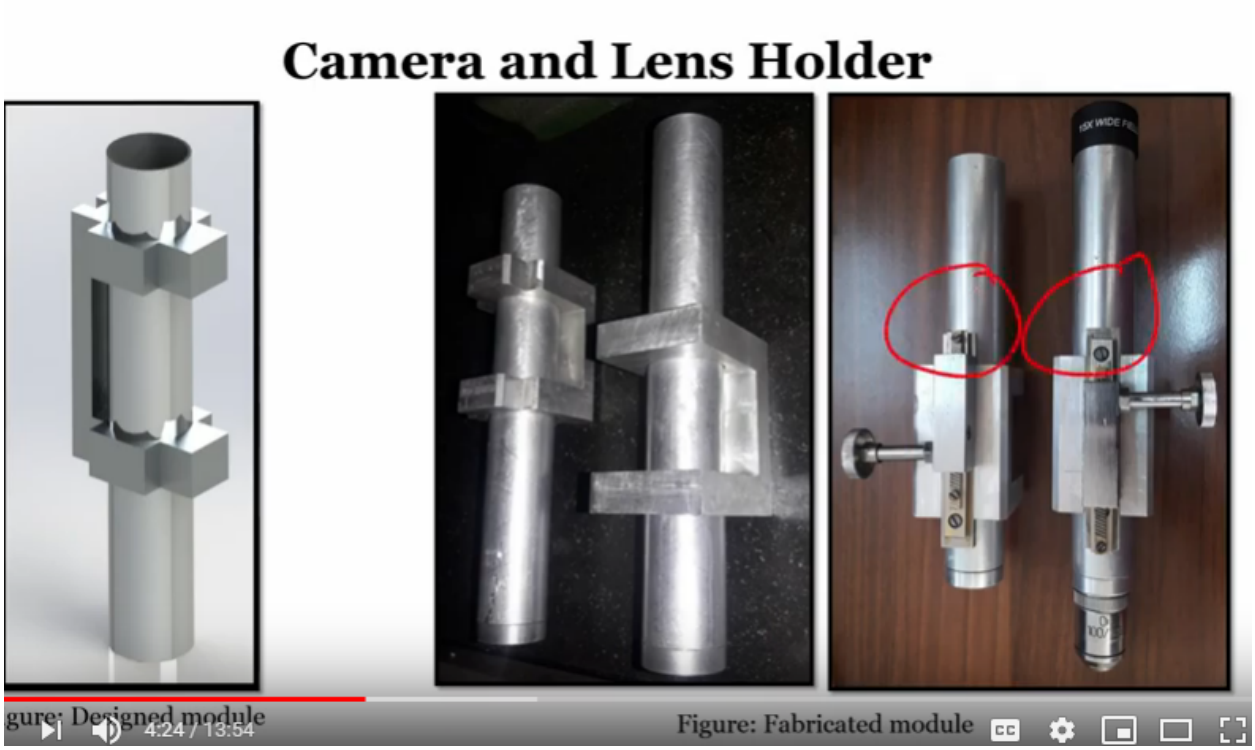

If you see this one Right? These are the camera and lens holder. Right? That we were talking about. So, left and Right? Both camera can simultaneously view the mask. Right? At the same time

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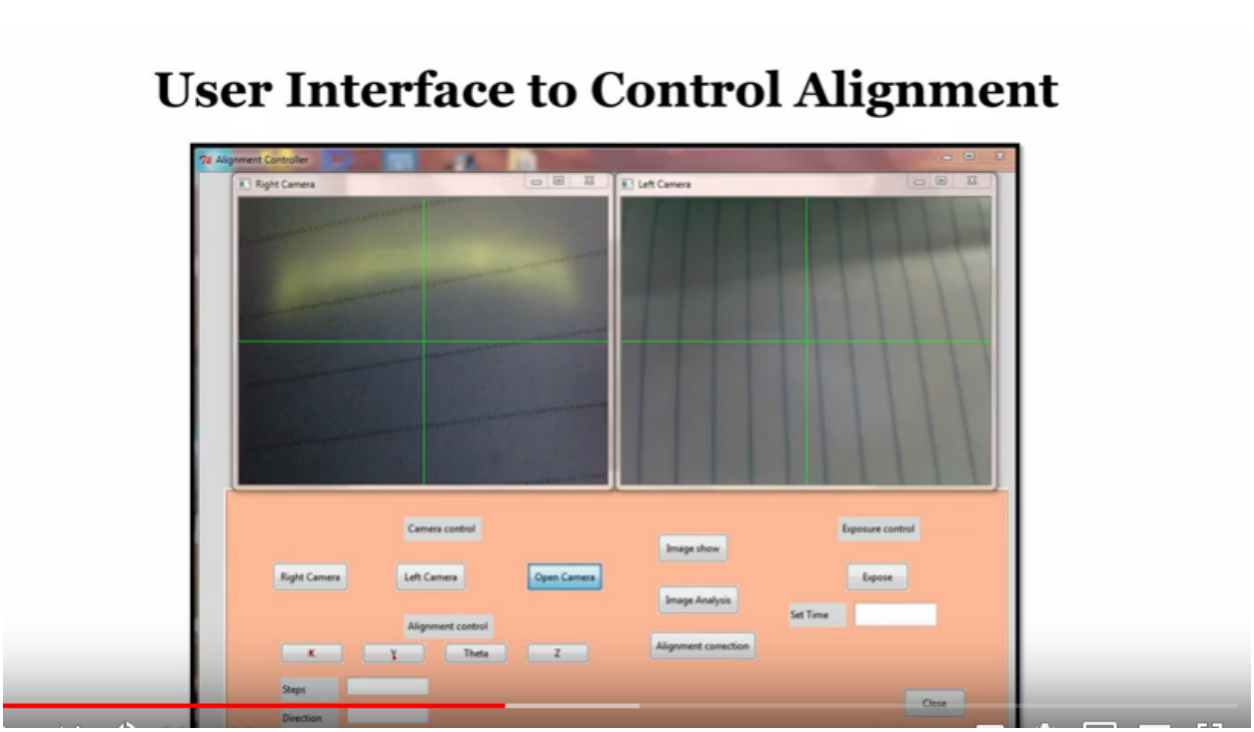

That's what we are looking at, this is a left camera, this is a right Camera. Right? And we can simultaneously look at both the cameras. Now other than that, what is that? So, we can, we can place, a button we can press, camera when the camera opens, you can, you can use left camera, you can use right 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, your substrate? It can be five second scan be, 10 seconds can be, 15 seconds depending on the material that you are using, if it is a, thin photo resist or thick photo resist if it is, su-8, 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 an alignment correction. So, we are trying to automized 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, to integrate with your mask render.

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UV Exposure System

- The UV exposure system consists of an array of UV LED and heat sink attached to it.
- As mask and wafer are aligned, the UV LED array is to be taken on top of the mask at a certain distance (to control the exposure) from its resting position.

Figure: Design of UV exposure system with heat sink

Now, when you talk about this the, main important point or the most important aspect, of the masculine in any mask aligner would be this source. Right? Because finally we had to expose, our UV light, our substrate with UV light. Right? So, if you have seen in conventional UV, mascara now the, the light source gets heated up, tremendously. Now 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, then, then that will be really awesome, because you know just by LED, array and anyone can change it easily. Right? The system is such that, you just, if the, 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 masculine immune 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 you expose system, we are trying to use UV LED, UV LED and heat sink, attached to it, as a mask can be further align, the UVLED arrays, 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 UVLED 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. Okay? From there, from its resting position. So, how does this, whole thing works. Right? Whatever, we have discussed,

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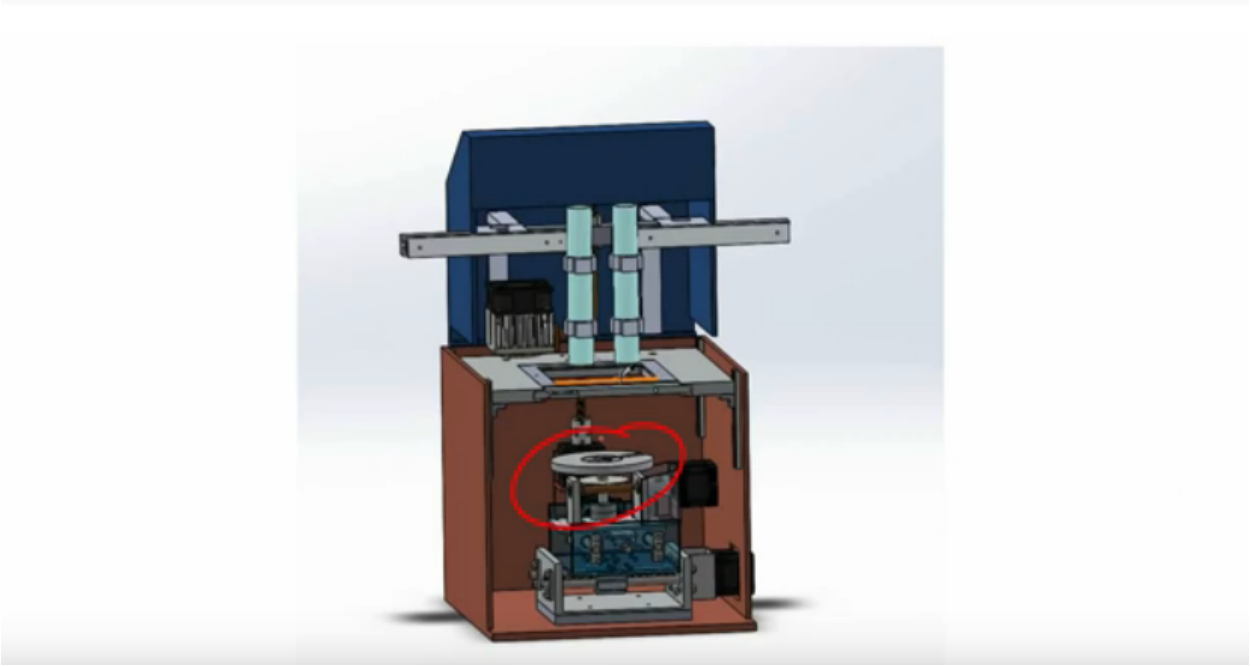

How does it work? So, this is, just an model to understand the system. Right? You can, you can see here, there is a wafer holder and here you can see there is, a mask holder. Right? And this prefers holder will come to the mask holder and that, it will get attached it is a hard contact, hard contact lithography; these are the lenses that we have. Right? And or you can say camera, these 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, what are the components? What are the tools? This is, these are the actuators, drivers to, 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 3d, solid box diagram, this is just 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, it comes after you align the mask, you press 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 loaf 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's 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 5 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, to encourage you, that you guys can do it, in your laboratory, in your college. Right? You don't have to have, high fi laboratory, a high fi technology, next to you to; start working on your research problem. Right? Yes, if you have it, all excellent, if you don't have it createone. 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, 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 and it works you can convert to a product. So, anyway, point is that don't, don't always think that, if you don't have certain facility, you cannot perform research. Right? That’s why I'm showing you, an alternative technology even I have, I am, in the Institute where we have, one of the best facilities, there micro engineer would, would, would like to have. Right? We have everything to name from photolithography unit, to react you anything, to wet etching, to dry etching, we have EB new peasant , puttering and we have XRD AFM, SEM, TEM for you name and we have it, but, but what, what about if we don't have it. Right? if we don't have it, if you don't 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 photo discography. Right? So, anyway, I will end up my lecture in this particular node and I'll see you in the next lecture, with 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 and why it is important, how you can create it, yeah. Take care. I'll see you, next class. Bye.