Sensors and Actuators
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Lecture – 26
Introduction to COMSOL Multiphysics and Modelling Examples

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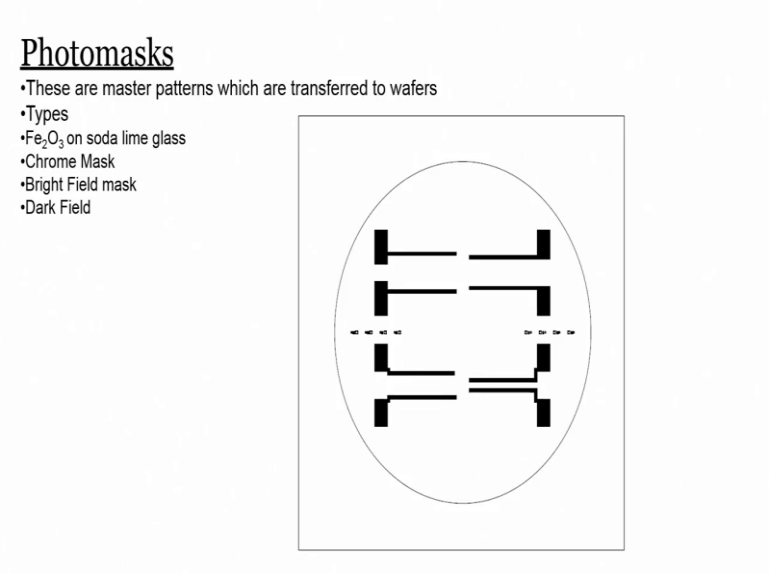

Hi, welcome to this particular module, we talked about photo mask right pause a bright field photomask and a dark field mask. This mask our master patterns which are transferred to wafers and the types of photomasks are the Fe_2O_3 on soda-lime glass. It can be a chrome mask, it can be a bright field and dark field as you know.

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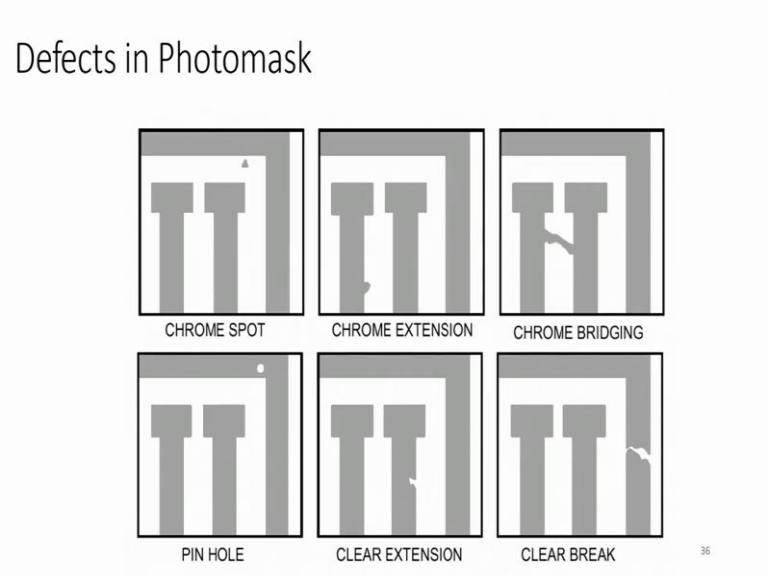

These are some of the defects that are available that are generally you know observed in a photomask, one is a chrome spot. Now, why it is not important why it is very important particularly when you fabricate MOSFETs, then within this area you will have few thousands of devices that you are that you will be killing because of that effects in that photomask which is your chrome spot.

If you see the second image you will see the chrome extension, suppose I fabricate a heater then this extension will create a different resistance compared to what I have calculated. Same thing if this is short it is not acceptable because two lines will be short of is a metal it is not at all acceptable. In other cases also it looks a lot of problems, if you have a spot then this particular area again you are killing the chip.

This crack will cause or clear extension or a crack will also cause a change in the resistance if it is a resistor. The other properties are also affected when you have this kind of defect finally, a clear break is not at allowed because you are if it is a conducting line and you are just breaking the connection. all this kind of defects are generally observed in a photomask, so before you use a mask make sure that this kind of defects is not there.

So, now let us understand and see the lithography videos where you will be understanding two times of lithography, one is an automated one and second is semi-

automated one. There is something called front to back lithography once we look at the video will be understanding what is front to back let me first play the first video.

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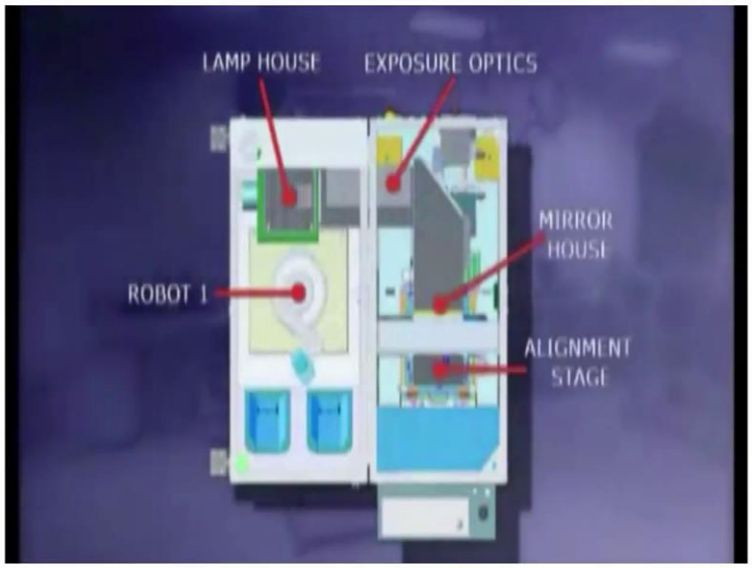

Hello, my name is Bernard from the SUSS MicroTech development team, today I would like to present our new generation of production aligner. The MA 200 compact which offers an advanced technology design, unmatched precision, and a high degree of flexibility; see for yourself, how easy it is to operate.

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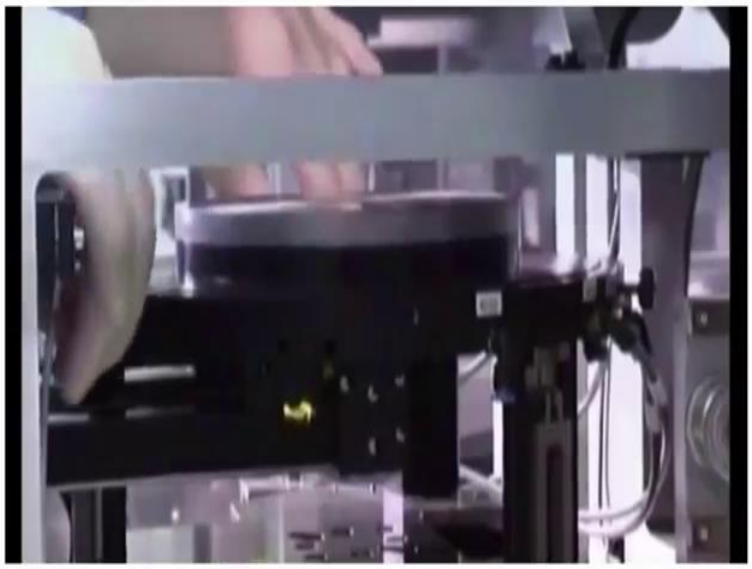

The chuck is stored in the bottom part of the aligner and is quick and easy to load.

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Equally easy to insert or the mask holder and the mask.

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Now, I load the carrier that is all there is to it and the MA 200 compact is ready for operation. The processes of the MA 200 compact can be controlled via a touch screen.

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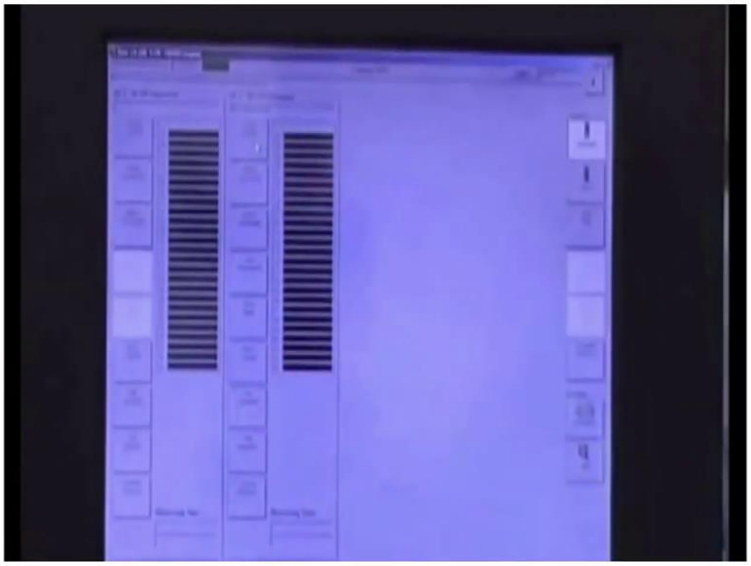

For some processes, you can select between fully automatic and manual operation.

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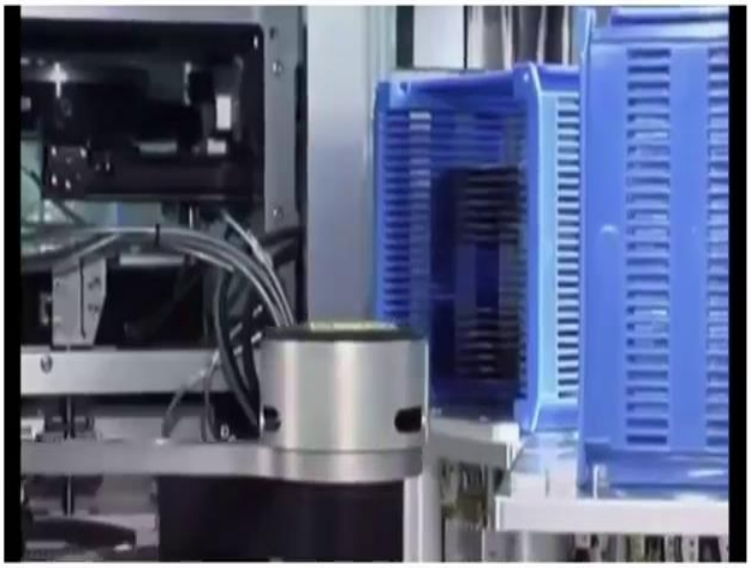

A robot scans the wafers and determines their quantity precession and size, and the processing begins

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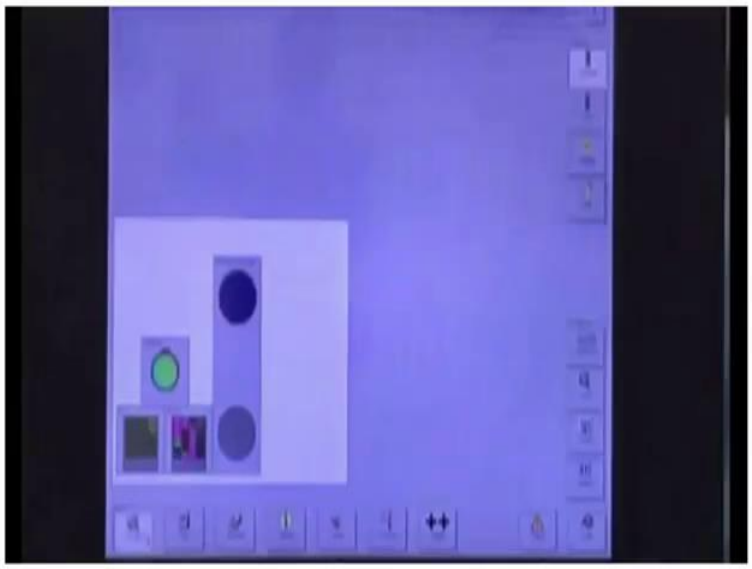

The MA 200 compact processes wafers and substrates up to 200 millimetres regardless of their material size shape and thickness.

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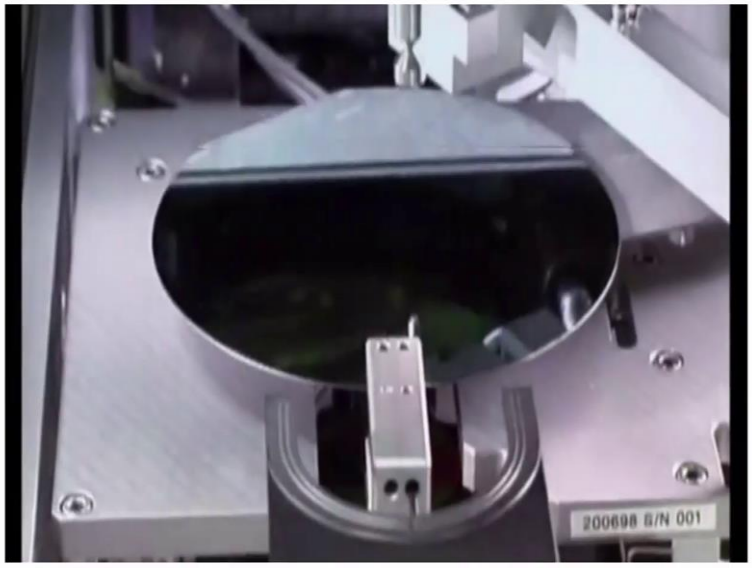

The machine runs and adjusts fully automatically and is optimized for the processing of thick resists such as with thick resist, left chip bumping, wafer-level packaging, MEMS nanotechnology or telecommunication devices.

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The big advantage of the steppers is the exposure of the entire wafer in one step, thus a throughput of more than 100 wafers per hour can be achieved with an overlay accuracy in the submicron range.

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Now, let us slow the process down and take a closer look. First, the wafer is pre-adjusted onto the pre aligner in preparation for the ensuing alignment. A linear transport system loads the wafer onto the exposure chuck which together with the robot arm guarantees the optimal and flexible handling of the substrate.

No other mask aligner on the market offers a higher degree of alignment accuracy than the MA 200 compact, with the use of the recently developed and patent-pending direct align option from suss.

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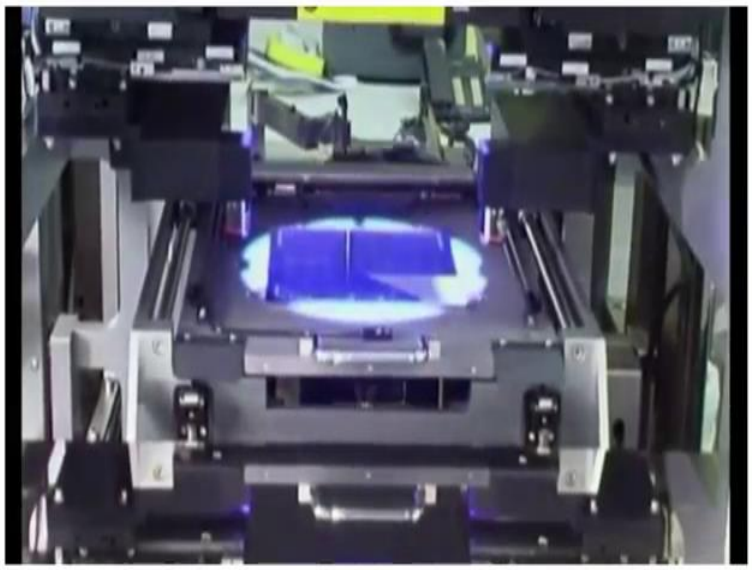

The mask is aligned directly to the wafer guarantee in and overlays accuracy of up to 0.5 microns at 3 sigma.

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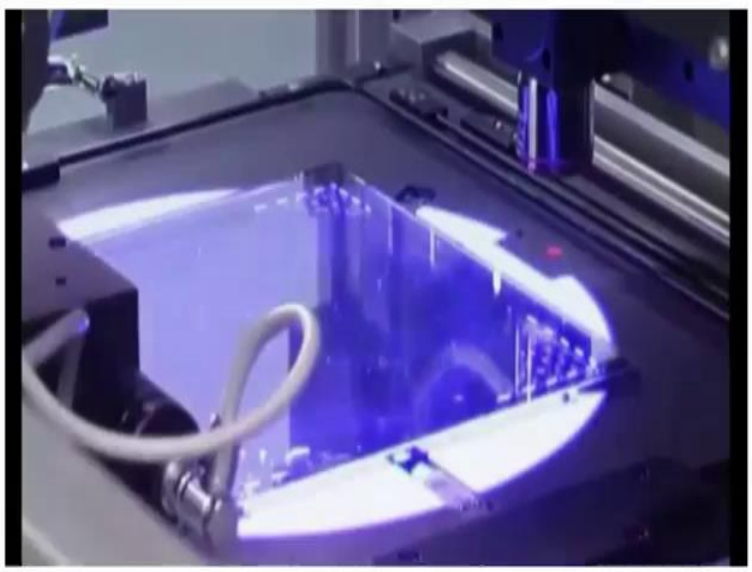

The structures of the photomask are conveyed via shadow cast, the patented wafer levelling system from SUSS compensate for topographic variations and wedge errors.

Thus guaranteeing perfect alignment and exposure results and the entire process is easy to monitor here on the touch screen.

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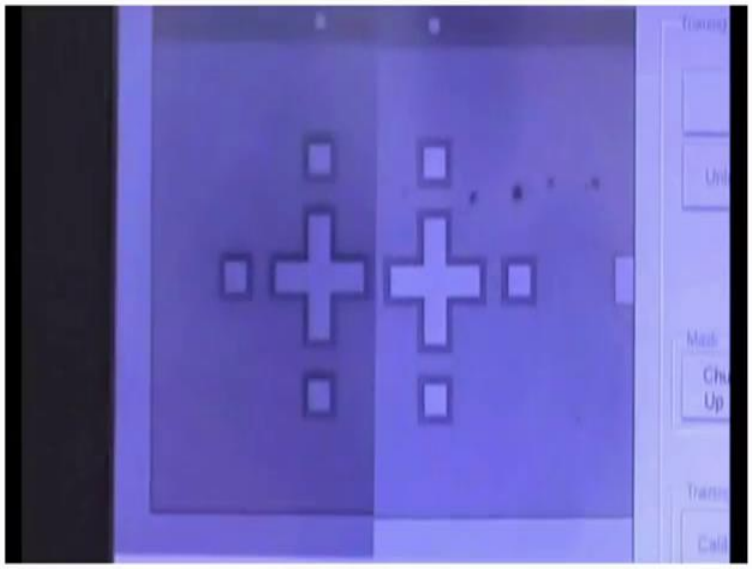

Because of the MA 200 compacts newly designed microscope.

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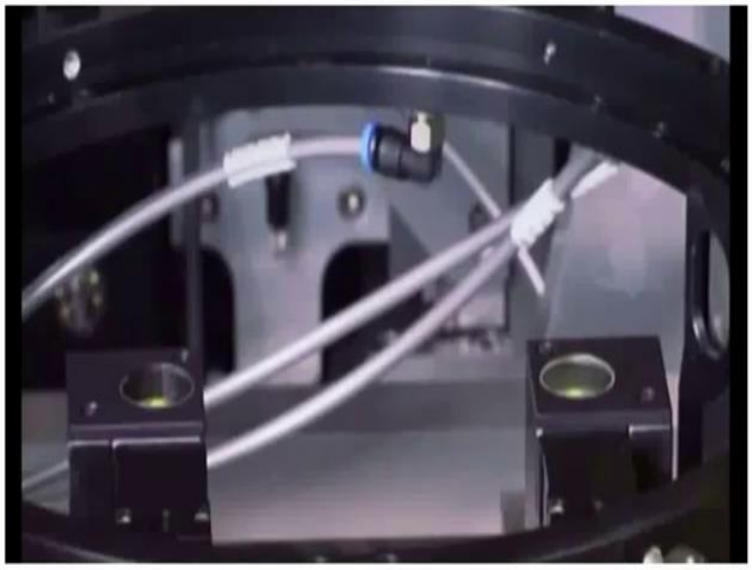

During exposure, the mirror housing does not move forward.

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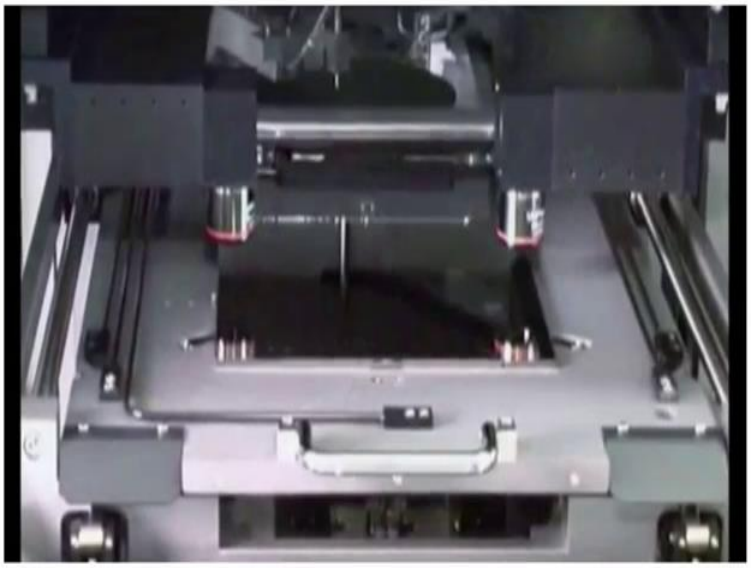

The microscopes only move sideways, thus reducing the vibrations of the alignment stage to a minimum resulting in far greater accuracy.

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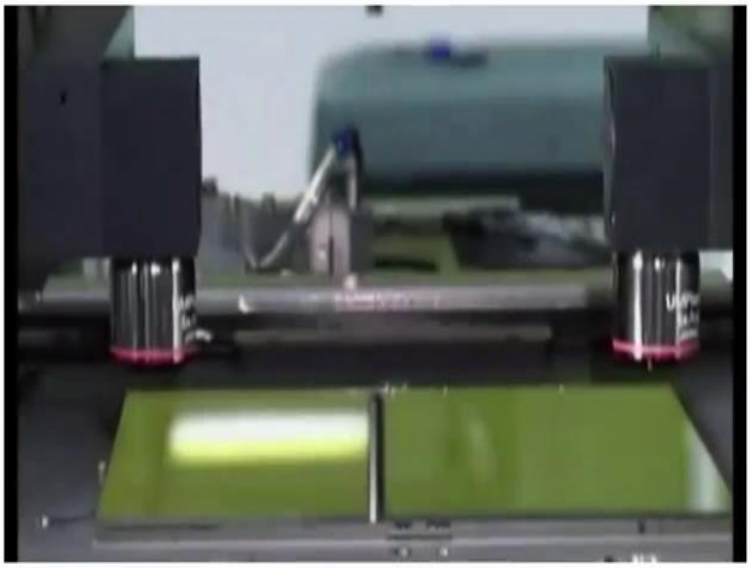

The optics of the MA 200 compact are optimized for thick resist processing and thin resists get achieves a resolution of 3 microns in proximity mode and the submicron resolution in contacts printing.

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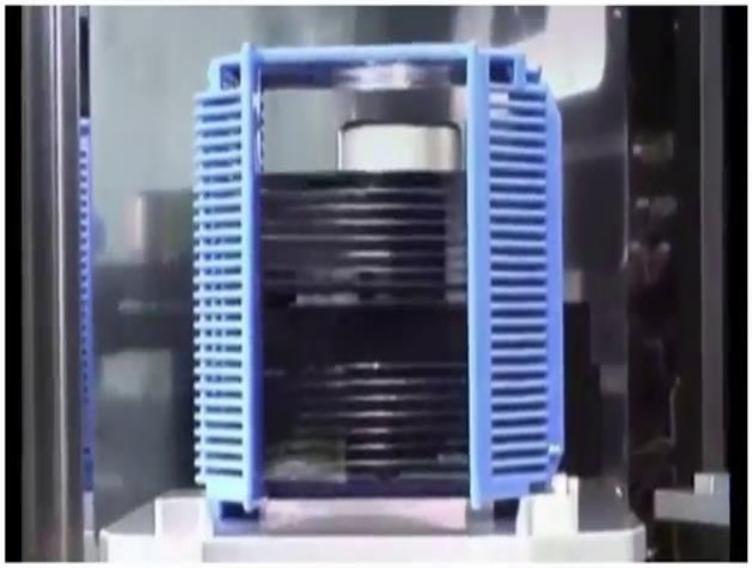

A microscope for bottom side alignment is optionally available; it can process substrates with thicknesses of up to 4 millimetres. The MA 200 compact is a master when it comes to detail our idea while designing it was to create a device that is both user and maintenance-friendly.

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In order to further reduce your operational costs, the electronics and all important components are easily accessible, as well as being arranged in a clear and magical manner.

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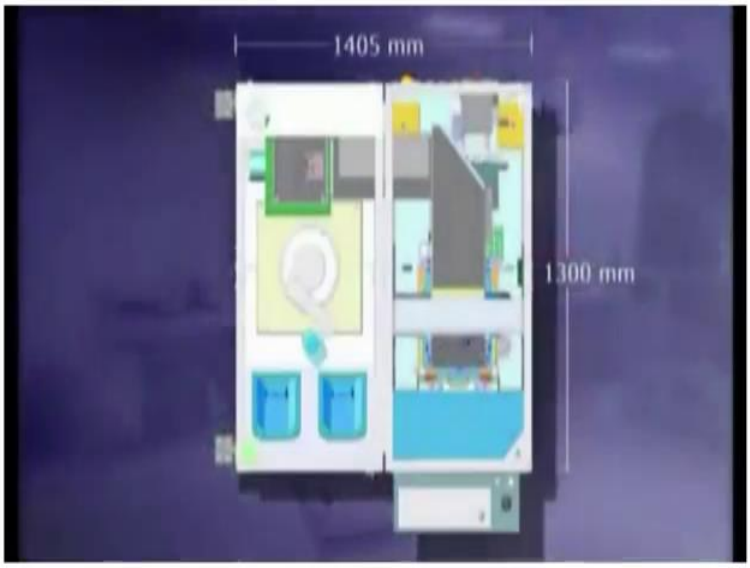

Because it is the compact size it also saves valuable space in the cleanroom.

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The MA 200 compact is the ideal exposure system for application areas with high demands in terms of package densities and micromechanical structures. I can only recommend that you take a closer look at our new mask aligner in person and would like to invite you to do so today, the MA 200 compact from SUSS MicroTech.

So you have seen the first video where it is about the automated kind of lithography system where the robotic arm will pick up the wafer and will spin coat the wafer and the exposure will be done. While the second video that I am going to show you now is a

semi-automatic system where the cleanroom user will show it to you how to expose the wafer from the front side as well as if I want to do front to back alignment how to go for backside the exposure; so I play this video.

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This is the MA 6 this used to expose a UV light to the substrate that has either photoresist on it. Before we learn the machine the first thing we got to do is make sure the light bulb is turned on or even not going up. we come out to the back.

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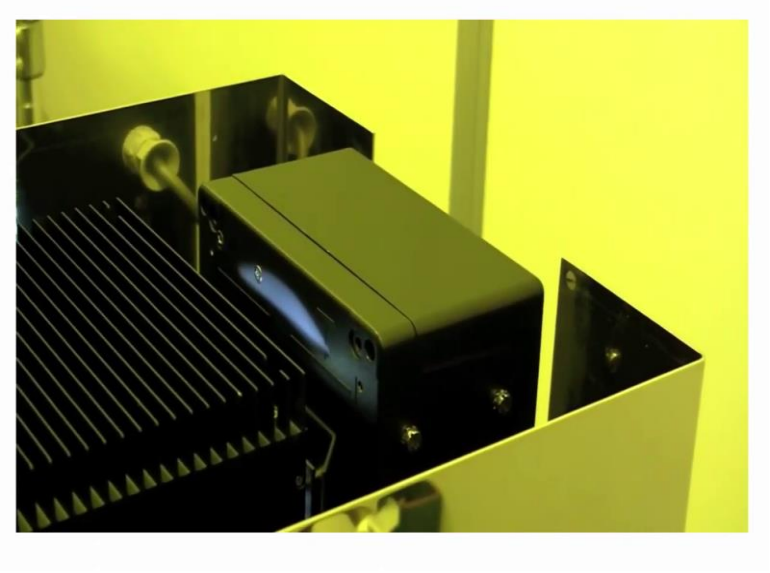

And you can see the lights turned on by the reflection here or you can see the light blowing. you know that the light bulb is on, but in addition to that, you want to find out how many hours are left on the light bulb.

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So, you check the power supply do you hold this button call the (Refer Time: 09:24) says 3 2 2 6, how many hours the bulb being used. The bulb has a lifespan of 4000 hours. when it is over 3500 we would notify staff and tell them to change it, so we are pretty close to that. Now, that the bulb is to use and that is nothing wrong with the bulb and the power supply, we want to log into the system. before we login topside we check the logbook.

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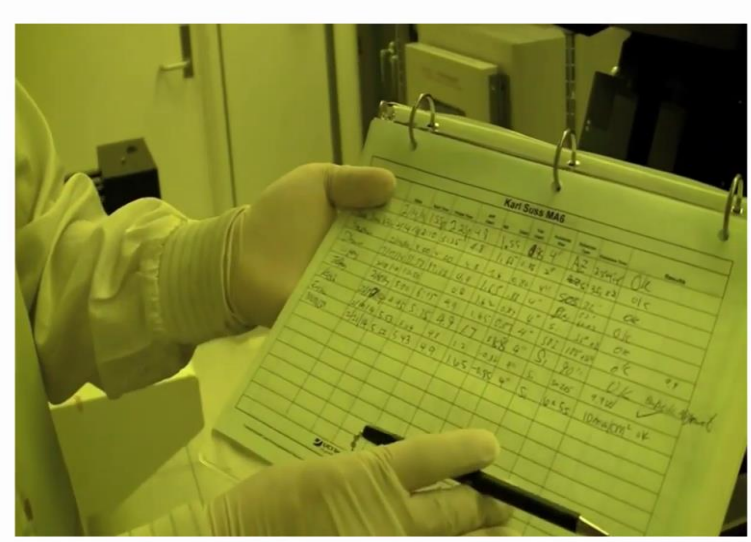

And the logbook would say that the last person who used it was Monica on 221 and then he would check no she had or anything was wrong. you see there is nothing wrong, so we are ready to turn the machine on and login.

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So, the log in computers here you have to login to use the machine otherwise you will not turn on, and the login has some of the functions first the screen is the login. you type the username and password, if you sketch row to use a machine in different hours. Also if you should check this to make sure nobody else is using it, So today is a 24 and it is 10 AM and nobody using it, so they are free to use it.

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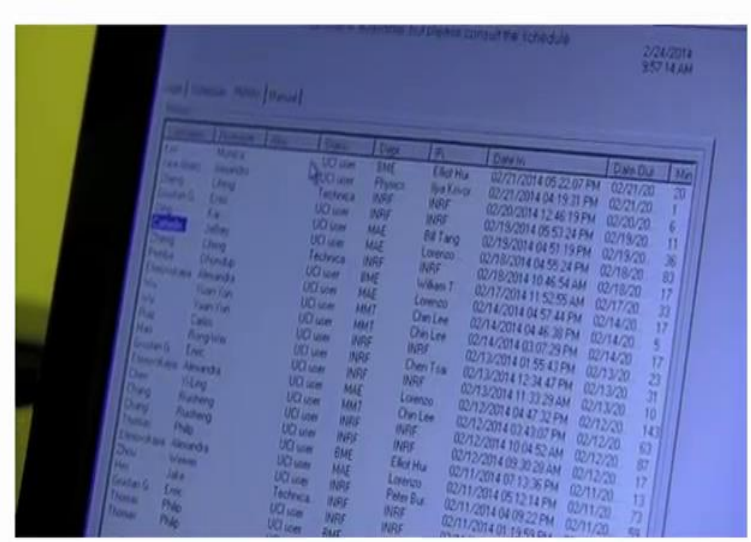

Also, there is a history tab where we can see the last user and you can see that Monica was the last user and she was the last one to write in logbook. Once we know the machines ready and it is very used we just login. once you have logged in the machine will be able to power up and what we do now is we turn the on switch on here.

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So, we just turn it to the on the switch, and you can see the machine starting up as important to read the screen it tells you a lot of information. it says the ready for start press load button, so the load buttons right here, now we press that and now it is a watch out machine is starting up. You know that the machine is ready for load and started up when if the information says ready for a load.

So, before we run the machine the one thing we can do is change the parameters, see hit this button called edit parameter. And now you can adjust the parameters such as time and gap distance and type of exposure. how do we edit the parameters change the different parameters either use the x left and right, so we move this way you can change the gap, change the type of contact and then change exposure type.

So, let us change the exposure time first, so it is at 5 seconds now we can change it to 25 seconds; if you hold fast and up you can change it faster. it is a 25, let us make it 26 now we want to go slower, so we do not get fast to just; so now, we have adjusted the exposure time. Let us change the alignment gap let us make that 40 and let us change the type of rule making soft contact.

Now, new parameters have changed, those different type of exposure types from some soft vacuum, hard if you look at some supplemental to get more information well right, now we will set it as soft. what is the primary set? We can hit the edit parameter, what we are going to do now is the load the mask. how do we load the mask we put up we press the button called change mask on the screen, so he changed mask you ready to load the mask, so we put it in here.

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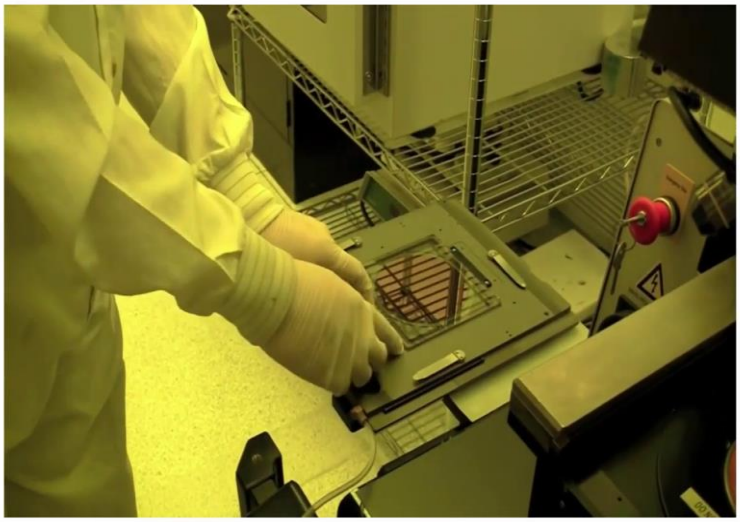

So, you load your mask in here by left in this crip here and putting it in and when it is in nice, you hit this button called enter you would toggle the vacuum. Right now the

vacuum is off, and then you press enter now the vacuum is on when you come back you can see that it is vacuum then in this stuck very well.

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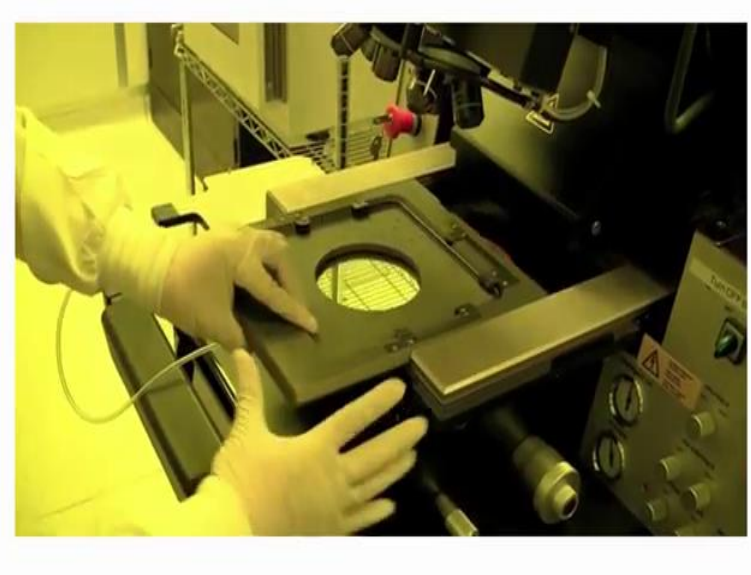

So, now we are going to put this in here, so we carefully carry it; oh, place it all the way in and when it is in the press change a mask. And that is how you load your mask when we are going to be doing a backside alignment now. What this does is it aligns features on the back of your wafer to your mask, and how you do it miss the middle microscope from the bottom.

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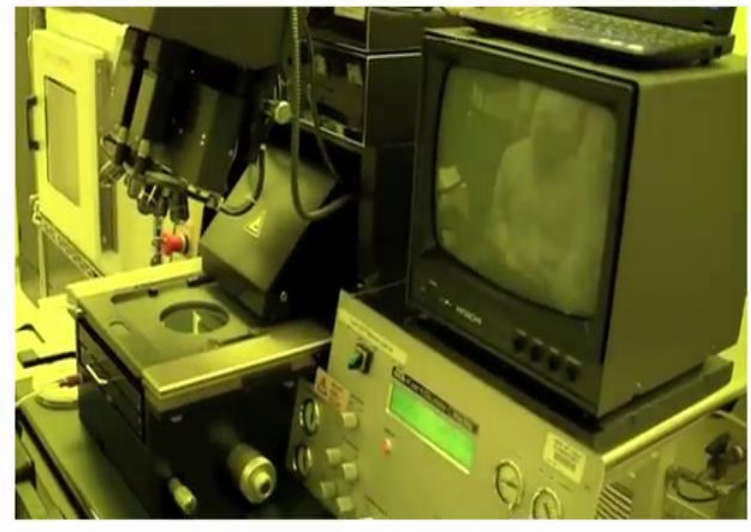

So, the first thing we do is though we have to have a mass-loaded and then we turn the screen on. Now, we make sure this thing as backside while the microscope is on it is on, but also we needed to change this to backside alignments. It can be either topside alignment or it can be a backside alignment, so this is an illumination, so now; the light is coming from the backside.

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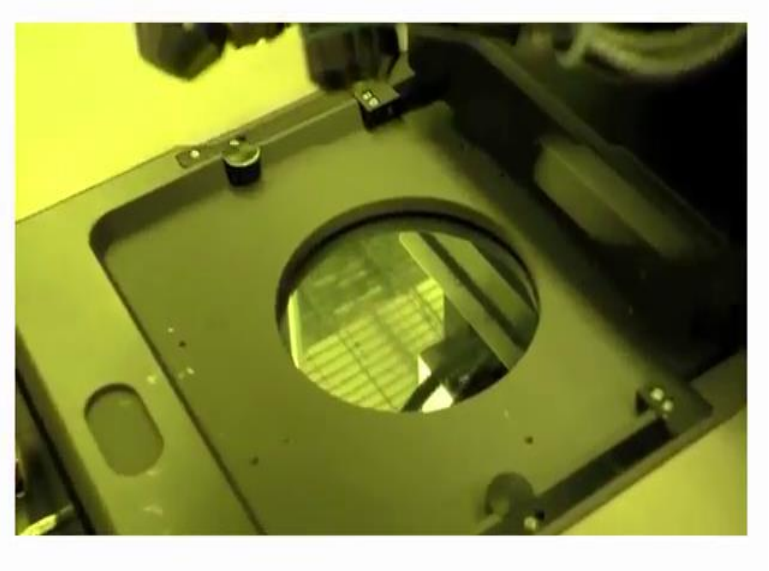

So, if you look in here, you can see the light setting the features, so that is the microscope from here coming look here am I setting it. we can look for those on the screen now.

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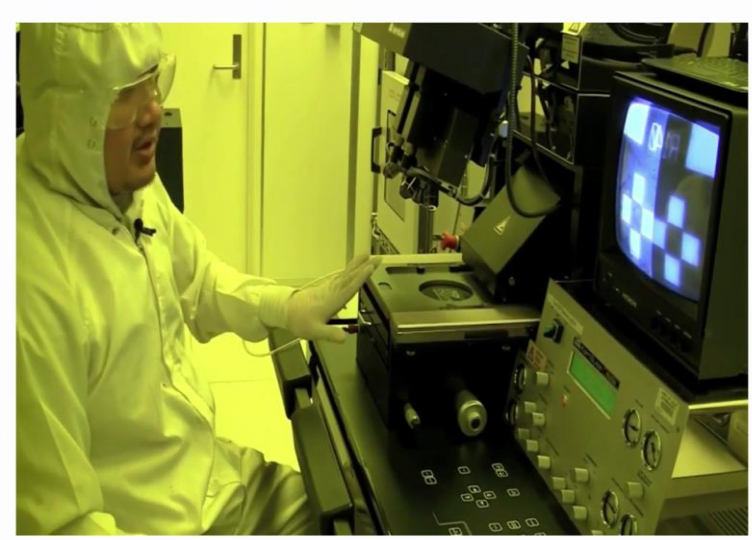

And pretty much you do is you are this controls the microscopes in the back, so you can select one at a time and move around to you find your features, it looks like we found alignment marks on the mask. We need to adjust the focus, he uses this top straight left and right, so the left one just the left you know I want to adjust the right focused.

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You can also adjust the intensity you can also adjust the position, so if I want to move this one up and down I will hit the. And then I will move it up and down if I want to hit with the left one it is a similar thing. When you find your mask and you think when it to

do exposure (Refer Time: 15:45) you will grab this image. you press grab image button over here and when you press that when it does it takes a picture of the mask. And now we were ready to load the wafer, we press this button versus load wafer, so it is a full side and substrate onto the chuck.

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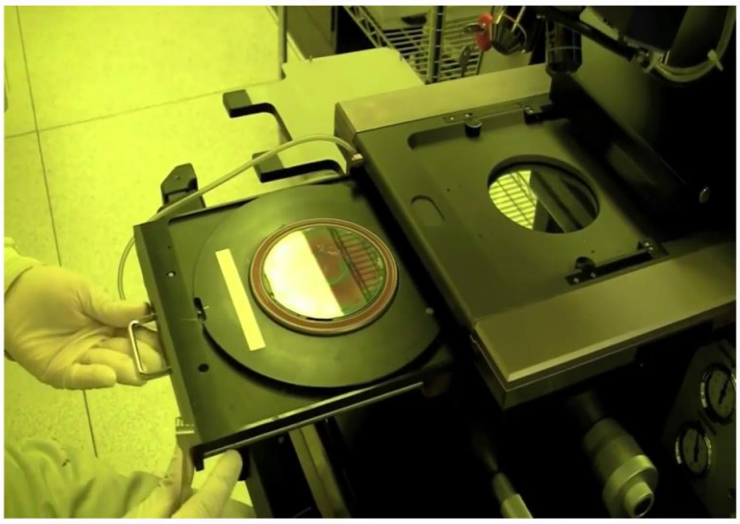

We would just load our waiver on and when it is in infrastructure and it will bring it up.

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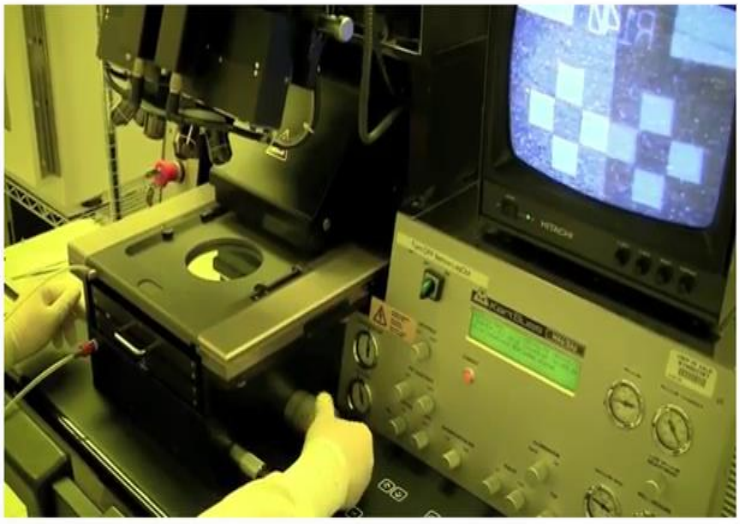

So, now you can see you are in contact this is the image overlay is in the mask, and these fishes right here, see then the bottom substrate away a wafer. how do you move the

wafer, we know that these buttons move the microscope side only moving the wafer it stays what is right, it is these knobs right here this is a y this the x is on this side and this is the tilt.

So, I will give you an example I can turn this, and you can see the background these images moving and then you can see this moving. this is the y position on the left side and that the y side is the x knob you can adjust the tilt with us too. And, how you can adjust the focus and you can adjust the intensity light, so you would do that to find your alignment marks and then align them.

So, once you have aligned them you are ready for exposure and how do you expose, the first you alignment chuck which will bring it up to touch we want to make sure nothing moved. And then when you get exposure is good to turn your back away from the light, so it does not damage your eye, so heat exposure and then we just turn away.

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So, after exposure you need to unload wafer, so what you do is you come to the screen and you say pull slide unload expose the substrate. is pull it out and then this is you press the enter button and then the vacuum will be released. Then you can take your wafer out and then you would put it back in, so that is how you unload your weight for after exposure.

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What we are going to do now is topside alignment by using the microscope on the top to align to the wafer that is underneath to the glass. to do topside alignment we need to move the backside microscope, so we press this button that turns it off, also we need it for the illumination to the top side and then now we can load our wafer pen.

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So, getting your first load it says pull slide and load the substrate onto chuck when you press enter we did that and the microscope will ultimately come down because we have the BSA microscope while a button off. Now, let us down we turn the TV screen on and what this is doing is taking it put an image from here onto the screen. again this these

buttons right here control the x and y position of the microscope, so it looks like we found something here.

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So, we can turn out it is pretty the power of the illumination is pretty high is not it, so he loads a power then you can see them. we got a find a mask aligned look on the other side, so there are functions on this knob by here.

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So, if you move in this one (Refer Time: 20:19) control the light microscope the x position in the y microscope and the left side has the same bulb. when I move the left

knob I can turn this way, but I know the right now if I can turn it this way. We can now adjust the tilt to make this match up by turning this knob by here.

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So, they look like it pretty matches stuff, so what would you do is you into the same thing as a simulated backside alignment you aligned marks on your wafer, so these right here.

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So, you can see that if I move this, there are always these knobs always show the substrate. When I know this you can see that this has been moved, so you can tell that is

the actual substrate moving enough the mask. you try to focus it, when you try to find your alignment marks and align them to the features.

And then once you have aligned that you do the same thing into an alignment chuck and I will bring the mask up and then you would expose it. You press to expose and then you do exposure that, so when you turn away, so the UV light does not a choice. After thermal exposure, you would unload your wafer, so it tells you four slide unload substrate. you pull it out (Refer Time: 21:59) and you take it out, whether you finish to a sample we will put this back in.

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Now, if you are done you want to move this back up and you do not want to bring it back down; this is where you pressed BSI bottom. by default this will not come down also to bring this up you can press F 1 then enter and it will bring the microscope up. It is always good to leave it in this perspiration for the microscope up and the BSI button on because now way, so microscope button comes on and off every time you are using it.

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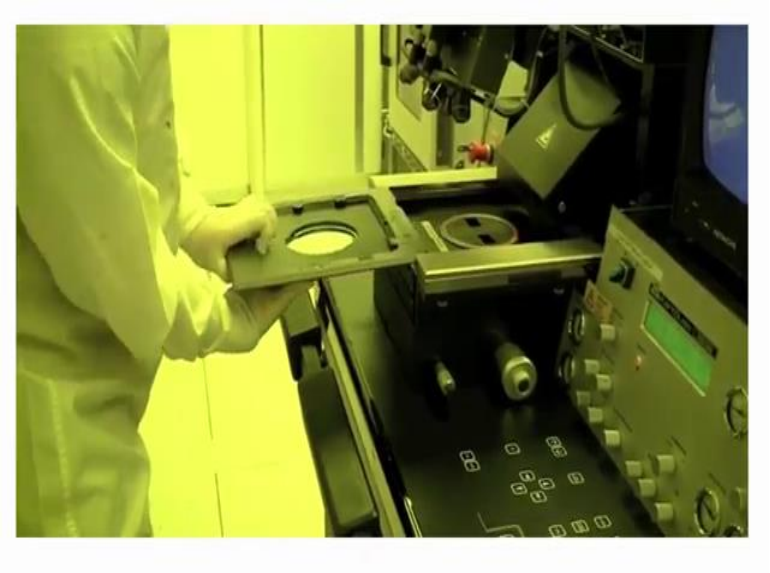

So, after that, we are ready to take out a mask before I will know the mass it is compressed change mask it is pretty similar to loading it. it is a reverse process. We will first change mask you would take you a substrate out you have to enter button to move the vacuum.

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And then you take your weight mask out you press the change mask button again and then (Refer Time: 23:11) formula enter as you know that mask is there. So now, we are ready to turn the system off. a lot to mixture everything's in the stand by position then you started the machine were and then before you turn it off you want to make sure you were right in the logbook two different parameters.

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So, the compost air is about 4.9, the nitrogen is about 4.65, the vacuum is about 0.86 taking the 0.8 we use the 4-inch wafer with silicon and we did 25-second exposure. Now, I ready to turn off first what we is doing is we will turn off the switch here, also the TV screen and then we can log out here. And some messages like the do we set the x, y and tilt position now we did that, so you put.

Ok, since here you have seen both the videos what we will be discussing in the next particular module is what the importance of front to back alignment is. Until now we were always understanding what is the front alignment, right and how the front alignment will help of how can we create different interdigital electrodes, if you want to create a sensing layer on it or something else we are always exposing from the front side of the wafer, but if I want to create a diaphragm, so let me give an example.

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If this is the wafer and this is the sensing area this one right this is the sensing area. I want to create a diaphragm exactly on the backside of this sensing area; that means, I should align it on this side how would I know it is perfectly aligned with the front side. That is what called front to back alignment and to create a diaphragm exactly below this particular sensing area.

This is where your front to back alignment will work we will take an example in the next module till then you just go through these slides. Again let me reiterate that if you understand photolithography you will be able to understand a lot of techniques, lot of sensors and actuators fabricating techniques will become easier. The heart of microengineering or microprocessing or manufacturing at a micro-scale is always a photolithography system.

So, if you have any questions feel free to ask me in the forum, if you have any doubts you know always feel free to ask do not hesitate because this is not, so easy to understand and at the same time it is extremely important. I do not want you to miss anything out of this particular module, but at the same time, it is not that difficult also if you really focus. let us discuss the examples of front to back in a next module and then we will actually move to the examples of using sensors, and microphonic systems for healthcare technologies right, till then you take care I will see the next class bye.