Electronic Systems for Cancer Diagnosis
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Lecture -06
Introduction to photolithography

Welcome, this is a very important module for this particular session of lectures. The reason is because we are today understanding a very important aspect and that is Photolithography. So, what is the purpose of photolithography and why we want to perform photolithography or why we want to understate photolithography? So, let us take few examples; let us take few examples so that you understand how we can use photolithography for fabricating different devices or different structures on the devices.

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Now, you I am holding one wafer in my hand right and it has few patterns it has few patterns. There is another wafer in my hand, again it has few patterns right. There are two wafers in my hand with few patterns as you can see right. Now how can you design this patterns? How can you design these patterns? The answer is photo lithography. So, we were we are learning how to perform photolithography. I will show you few more device just to make sure that we clearly understand what we are learning today. You see there is a heater on this; if you can zoom in little bit yeah.

So, you can clearly see or hopefully you can clearly see, there is a heater which is right over here in this area all right and these are two contact pads of the heater contact pads of the heater. Heater is right here two contact pads of the heater. How can you fabricate this heater that is the question all right? How can you fabricate this heater? And we will learn this thing today all right. And then you will see them in subsequent classes when we talk about micro ranging devices for clinical perspective right, how can you fabricate those devices using photolithography?

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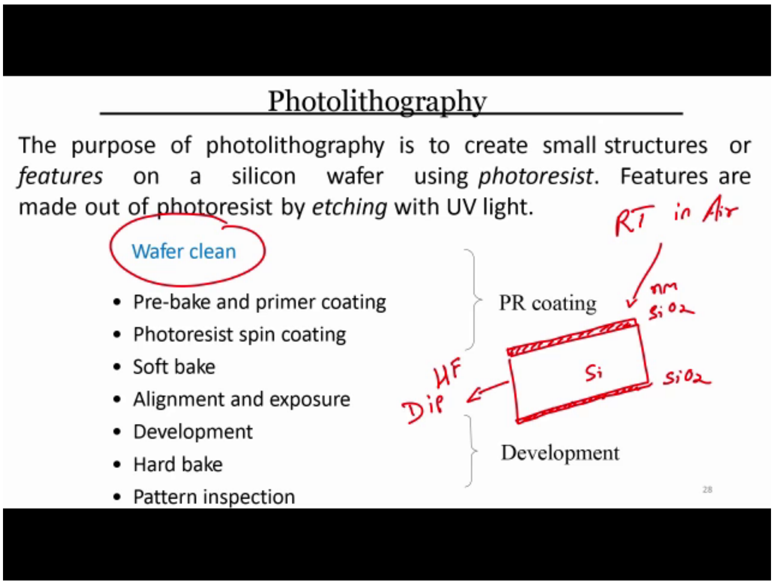

Photolithography

The purpose of photolithography is to create small structures or *features* on a silicon wafer using *photoresist*. Features are made out of photoresist by *etching* with UV light.

Wafer clean

- Pre-bake and primer coating
- Photoresist spin coating
- Soft bake
- Alignment and exposure
- Development
- Hard bake
- Pattern inspection

PR coating

Development

So, let us see on the screen photolithography. Photolithography comes from a word photo and then lithos. So, lithos and graphy is a Greek word used, which means carving from a single stone; carving from a single stone. The purpose of photolithography is to create and of course, photo means nothing, but photons light right; light to carve a single stone. Here in our case is a single crystal which is silicon.

So, anyway the purpose of photolithography is to create small structures or features on a silicon wafer using photoresist. We will see what is a photoresist and features are made out of photoresist by etching with UV light. So, what we understand? We can create small features one, we can use silicon wafer. But it is not just limited to silicon wafer; we can also use glass as we have just seen. We can also use an insulator, like alumina. There is a polymer involved and that polymer is called photoresist. This polymer is photosensitive polymer and we will be using this polymer to create several features by etching the polymer with the help of UV light.

So, now when you talk about photolithography, there are several steps involved and the first among several step is wafer cleaning. You cannot or you should not start any process in micro engineering without cleaning the wafer. Now, cleaning the wafer does not just mean to clean by clean with di water or to dry with nitrogen or to just pre bake it. Cleaning of wafer means like we have discussed in other earlier classes right; we have a wafer, we have a thin layer of oxide even we do not do anything in air at room temperature in air, there will be thin layer of oxide few Nano meters right; few Nano meters of oxide grown on silicon wafer.

So, first thing that you have to do is dip this wafer in HF Dip. This is very important. When you perform HF Dip, what you will see is the silicon dioxide; the silicon dioxide can be etched from silicon wafer. After silicon dioxide is etched, then you have to perform the rest of the step which is cleaning with DI water seionized water, followed by drying with N 2 nitrogen air right followed by pre baking pre baking all right to remove any moisture on this surface.

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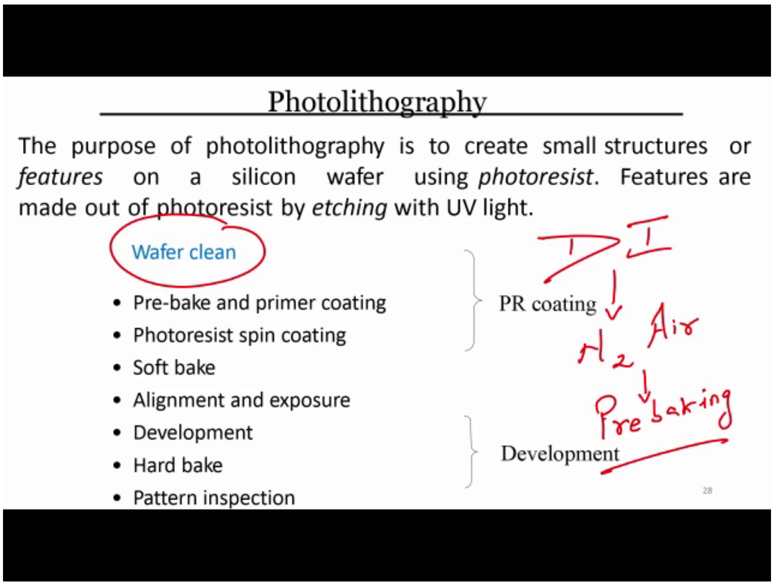

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PR coating

Development

DI

↓

N_2 Air

↓

Pre baking

So, what are the process? First you have to perform HF dip, then you have to clean the wafer or rinse the wafer with the help of DI. After rinsing the wafer with DI, you have to dry the wafer with help of nitrogen. After drying the wafer be nitrogen, you have to pre bake the wafer to remove any moisture; after this your wafer is ready for photolithography. So, to perform photolithography the first step would be, if you see the screen first step would be pre baked, we performed pre baking already and primer coating.

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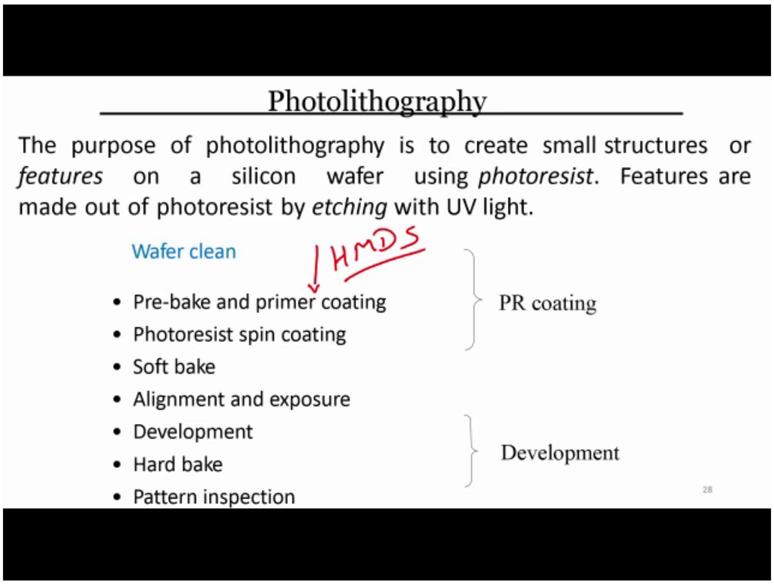

Photolithography

The purpose of photolithography is to create small structures or *features* on a silicon wafer using *photoresist*. Features are made out of photoresist by *etching* with UV light.

Wafer clean

HMDS

- Pre-bake and primer coating
- Photoresist spin coating
- Soft bake
- Alignment and exposure
- Development
- Hard bake
- Pattern inspection

PR coating

Development

HMDS is one of the primer that we can coat and this will improve the addition of photoresist on to surface of the substrate. After coating HMDS or primer, the next step is photoresist spin coating. We have two spin code photoresist and the thickness of photoresist depends on the rpm and depends on the time right. How many rotations per minute, we have programmed? For how much time we are spin coating the photoresist? Based on or depending on rpm and time we can know or we can determine thickness of the photoresist.

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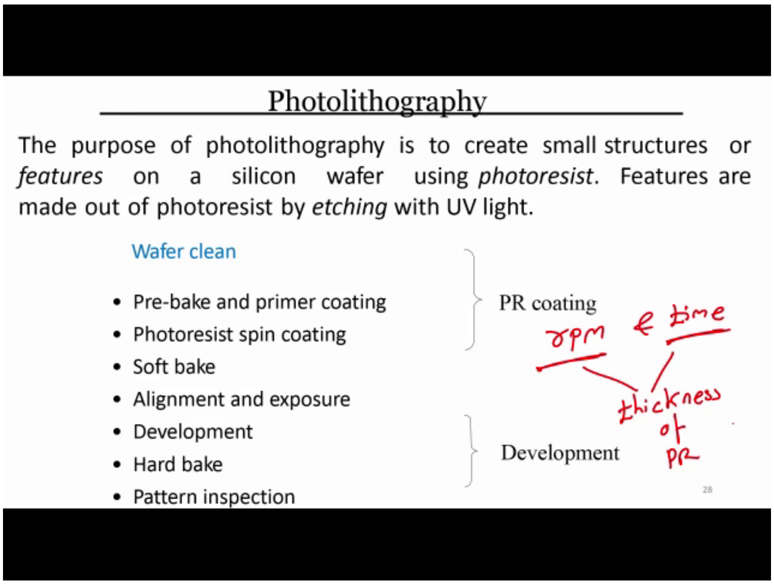

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Wafer clean

- Pre-bake and primer coating
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PR coating

Development

So, once we perform spin coating with photoresist, we go for soft bake.

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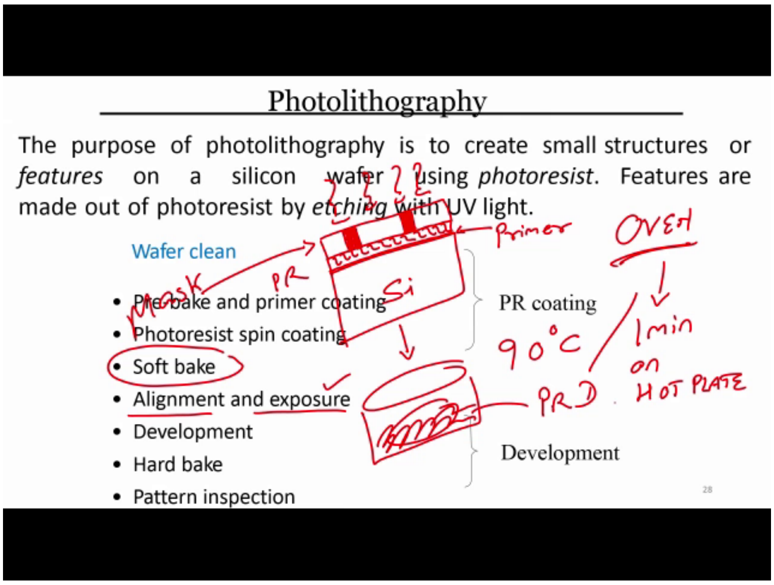

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Wafer clean

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PR coating

Development

Now, in a conventional situation soft bake is done at 90 degree centigrade for 1 minute on hot plate. This time would vary if I use oven. After soft baking, I have to perform alignment and exposure. So, I have a wafer, I clean the wafer and then on this wafer, I coat a primer; on the primer right I of course, pre bake it and then coat the primer. On that I will spin coat my photoresist; spin coat my photoresist. This is my silicon, this is my primer. After photoresist, I have to get a mask, let us say this is a mask. We will talk about the mask and photoresist, how it will work depending on its type; masks are also classified depending on its pattern that is we will discuss it later. So, this is your mask. You do align the mask and then perform UV exposure right. After UV exposure, you have to unload the mask and dip the wafer and dip the wafer in a beaker which contains photoresist developer.

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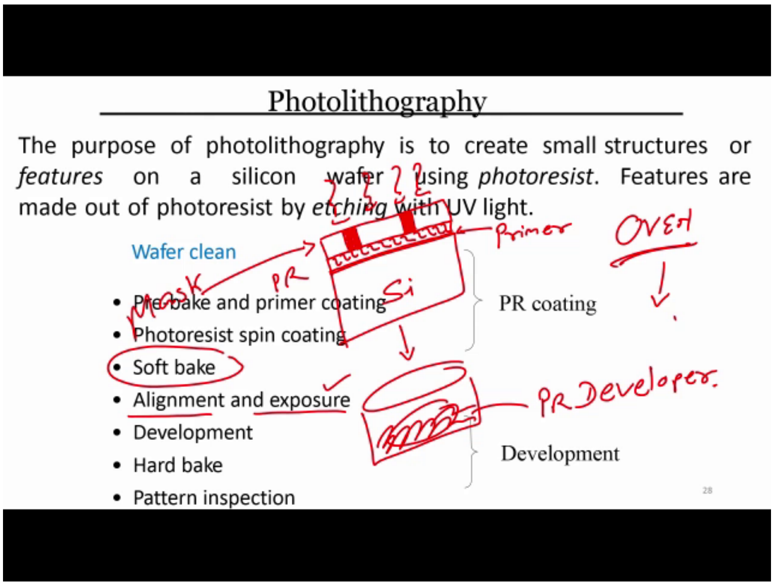

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PR coating

Development

After developing photoresist, you have to take out the wafer and perform hard baking.

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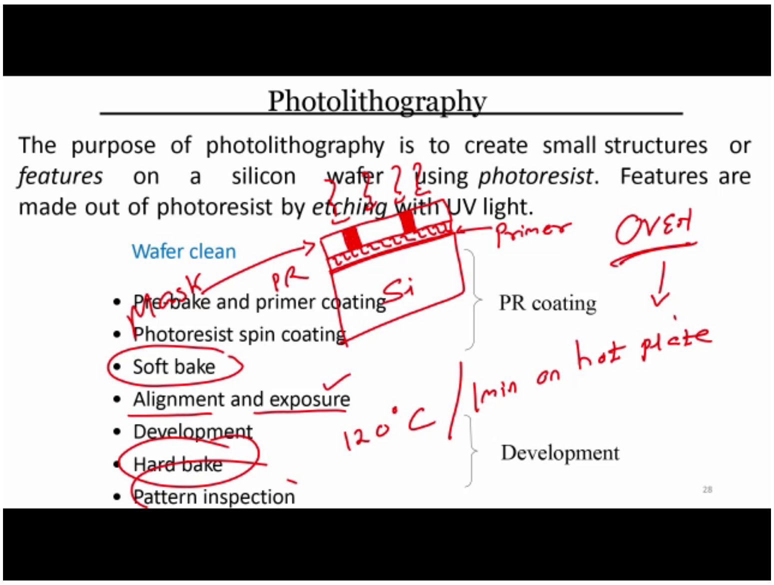

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Development

Hard baking in a conventional way, convention photoresist that is positive negative photoresist is performed at 120 degree centigrade 1 minute on hot plate. Let us write it down on hot plate. After performing hard bake, you can inspect the pattern; after performing hard bake next step is inspecting the pattern.

So, we will take an example, we will take an example to see what we have discussed right now so, that we understand clearly how photoresist or how photolithography can be used.

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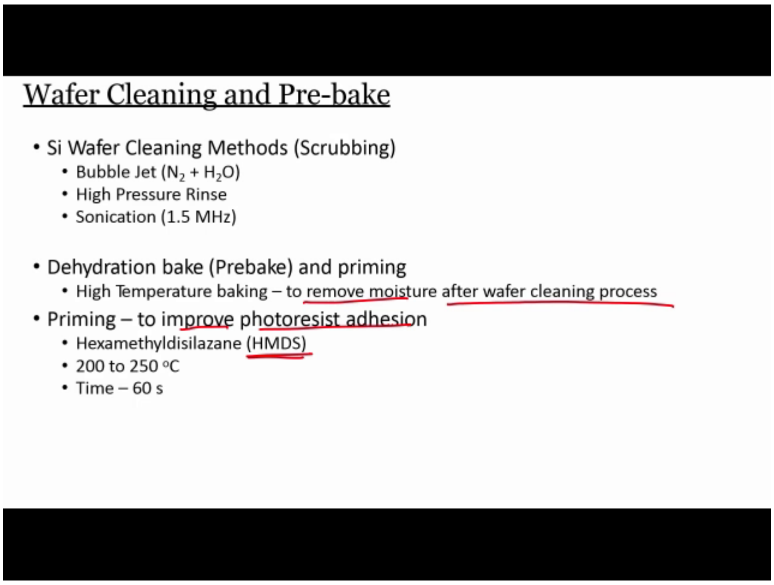

Wafer Cleaning and Pre-bake

- Si Wafer Cleaning Methods (Scrubbing)
  - Bubble Jet ($N_2 + H_2O$)
  - High Pressure Rinse
  - Sonication (1.5 MHz)

- Dehydration bake (Prebake) and priming
  - High Temperature baking – to remove moisture after wafer cleaning process
- Priming – to improve photoresist adhesion
  - Hexamethyldisilazane (HMDS)
  - 200 to 250 °C
  - Time – 60 s

So, like I said before cleaning and pre bake can be done by Bubble Jet, high pressure rinse by sonication, dehydration or pre baking can be done at high temperature baking to remove moisture right, to remove moisture after wafer cleaning process. Priming or primer is used to improve photoresist addition. HMDS is used, HMDS is your Hexamethyldisilazane and that is used to improve the addition of a photoresist onto the substrate.

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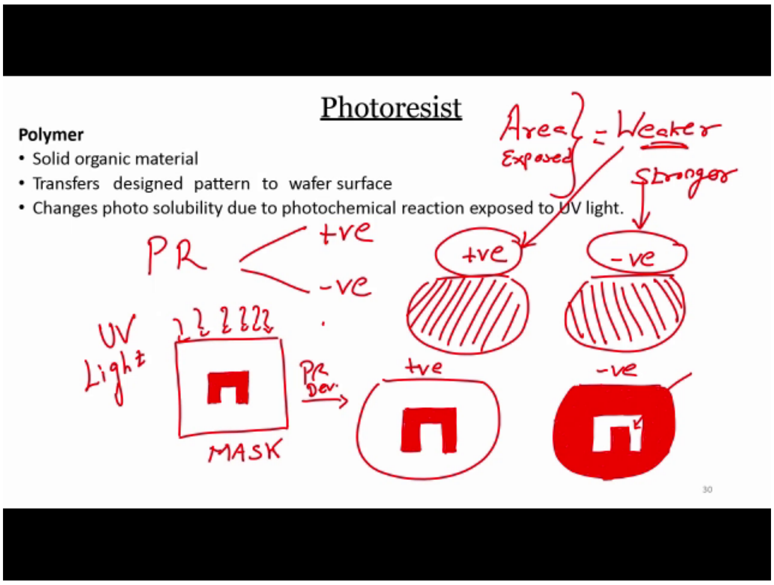

Photoresist

Polymer

- Solid organic material
- Transfers designed pattern to wafer surface
- Changes photo solubility due to photochemical reaction exposed to UV light.

So, what is photoresist? Photoresist is solid organic material. It is used for transferring the design pattern to this wafer surface. Changes photo solubility due to photochemical reaction exposed to UV light. So, let us first understand the role of photoresist. So, if I say, I have photoresist; photoresist are 2 types: one is positive photoresist, second is negative photoresist. Now, let us take an example of this particular pattern. Now, there are 2 wafers or let us draw the top view of the than cross sectional view. There are 2 wafers: one wafer is coated with positive photoresist, second wafer is coated with negative photoresist; this is your mask this is your mask.

So, if I use this mask on the photoresist so I have to; so what does that mean? If I keep this mask on this wafer like this and the wafer is coated with positive photoresist. What will happen that when I expose this when I expose this, I will have when I expose it to UV light and I develop the wafer right in which I use this kind of mask, then I will have my photoresist protected in this area.

So, what do you understand here? What we understand is that the area which is exposed becomes weaker and the area which is not exposed becomes stronger right, why? Because our mask was this right and we had positive photo resist coated on the wafer and this wafer if I place under this mask and if I expose it and I develop it, then I obtain this pattern for positive photoresist.

In case of negative photoresist; in case of that instead of positive photoresist, we have used wafer which was coated with negative photoresist negative photoresist, then when I expose with UV light when I exposed with UV light, what I obtain? I obtain pattern which I am drawing right now. I will obtain a pattern which looks like this. Take 1 more minute because it is very important I do not want to rush it through yeah. You see, so that is if I use negative photo photoresist sorry and I used this mask, then I obtain this kind of pattern, and this pattern means that the area which was exposed gets stronger and the area which was not exposed gets weaker.

So, in case of positive photoresist and negative photoresist, we had to remember in positive photoresist they exposed. Let us see here a lesser I do not exposed, can you see? No, exposed let us say area exposed becomes weaker; in case of negative photoresist, it becomes stronger. Which one? Area exposed, in case of positive photoresist it becomes weaker; in case of negative photoresist, it becomes stronger. You can see here right, this is the area where you just move remove the mask remove the wafer sorry then you can see this is the area which is not exposed the area here which is not exposed remaining area is exposed.

So, in case of positive photoresist, what I obtained is the area which was not exposed get stronger area which was exposed gets weaker here correct. In case of negative photoresist, the area which was exposed this area this one; this area is exposed right is transparent is exposed. Exposed under what? UV light area which was exposed became stronger and area which was not exposed, this is the area which is not exposed correct. Becomes area which is not expose becomes weaker in case of negative photoresist, you can see here. It becomes weaker. So, photoresist is developed in this area. So, you it is very important to understand photoresist because we will be using positive and negative photoresist extensively when we understand photolithography.

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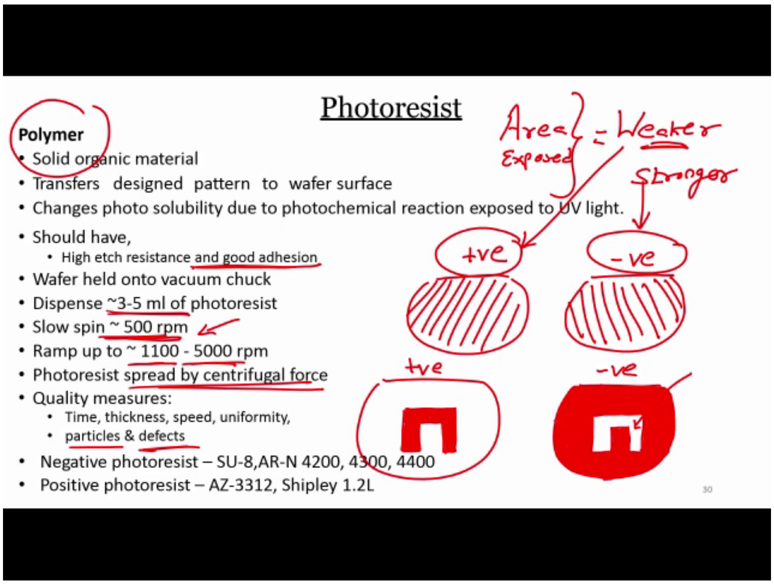

Photoresist

Polymer

- Solid organic material
- Transfers designed pattern to wafer surface
- Changes photo solubility due to photochemical reaction exposed to UV light.
- Should have,
  - High etch resistance and good adhesion
- Wafer held onto vacuum chuck
- Dispense ~3-5 ml of photoresist
- Slow spin ~ 500 rpm
- Ramp up to ~ 1100 - 5000 rpm
- Photoresist spread by centrifugal force
- Quality measures:
  - Time, thickness, speed, uniformity,
  - particles & defects
- Negative photoresist – SU-8,AR-N 4200, 4300, 4400
- Positive photoresist – AZ-3312, Shipley 1.2L

So, let me show you few more points. Now, what should the photoresist consist of? What this is a polymer should have? Polymer should have high edge resistance and good addition that is a requirement right. And how it is perform this? How the polymer is coated onto the wafer? These are the steps: first this spends 3 to 5 ml of photoresist, second slow spin at 500 rpm followed by high ramp up to 1100 to 5000 rpm depending on the thickness that you want.

Photoresist is spread through centrifugal force and the quality measures for this photoresist can be time, thickness, speed, uniformity also we can see particle if particles and defects if any on the photo resister. When we coat the photoresist, we have to take care of this many parameters.

Now if you see here, there is a requirement of slow spin. This slow spin is to uniformly distributed photoresist onto the wafer and then we ramp it up to 1100 to 5000 degree 5000 rpm so, that we can obtain the thickness of our desire.

Now, there are 2 types of photoresist like we have discussed here, positive and negative type. Negative photoresist can be SU-8, it can be N-4200, 4300, 4400. Positive photoresist can be AZ-3312, it can be from Shipley 1.2 liters. Now Simply 1.2.

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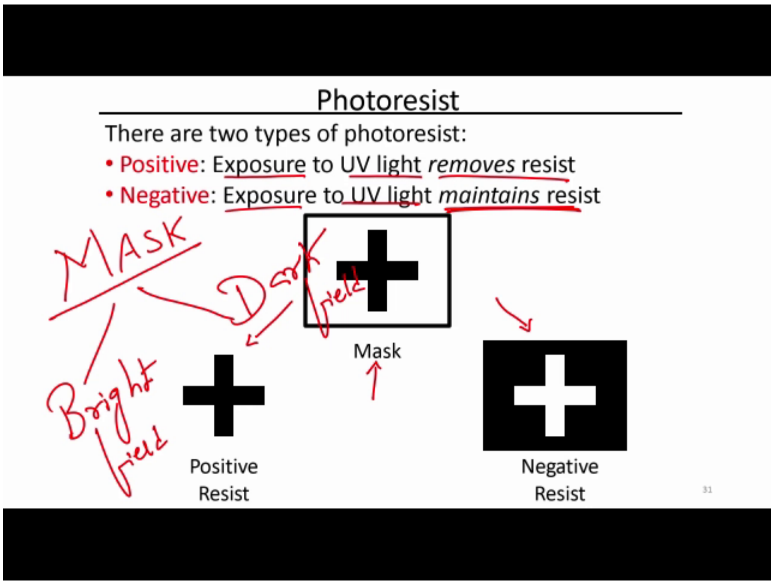

Photoresist

There are two types of photoresist:

- Positive: Exposure to UV light *removes* resist
- Negative: Exposure to UV light *maintains* resist

So, like I said when you talk about photoresist, photo resist are 2 types: one is positive photoresist that is exposure to UC light removes this resists, exposure to UV light removes the resist or exposed region becomes weaker correct. Negative photoresist exposure to UV light maintains resist or the exposed region becomes stronger. So, this is a case that if you have a mask, then if I use positive photoresist, I will obtain this pattern. If I use negative photoresist, I will obtain this particular fashion; if I use the mask which is shown in schematic here.

So, since we were talking about masks, let us see how the mask looks like; how the mask in reality looks like. So, when we talk about masks, mask can be bright field mask, it can be dark field mask; bright field, dark field two types of mask bright field and dark field mask. So, let us see how bright field mask looks like, let us see how dark field masks looks like. So, I will show it to you mask holder, mask is in my hand.

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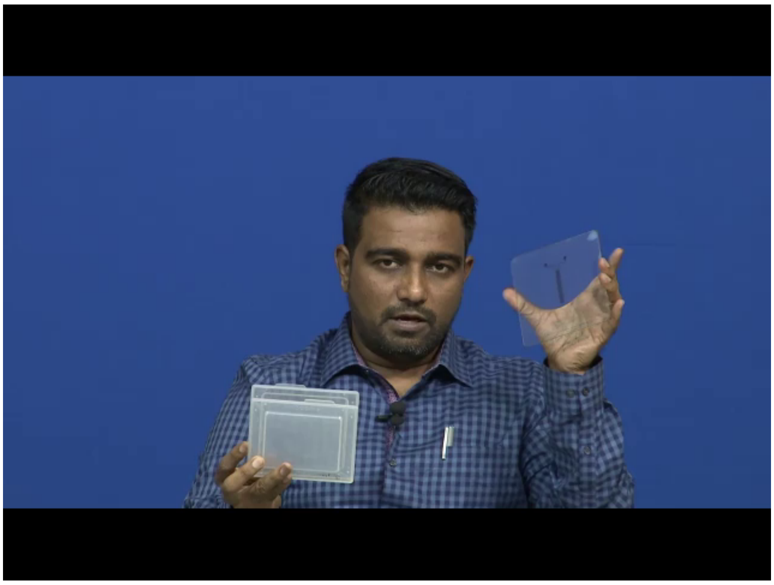

So, you do not have to worry about zooming in this time. You just see that I am holding a glass plate, I am holding a glass plate right. This is a 5 inch mask, why we are using five inch mask?

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Because we were interested in using a 4 inch wafer like this correct. We were interested in using 4 inch wafer 4 inch wafer, 5 inch mask. So, whenever you are using wafer depending on this diameter of the wafer, you have to change the size of the mask.

Now, what you see in mask? Can you see my finger, can you see my face? You can right, but there is some pattern through which you cannot see; through which you cannot see. So, most of the area in this mask is empty, is transparent. So, this mask is nothing, but bright field mask field is bright. You see this field is bright; bright field mask and there is some pattern on the mask; there is some pattern on the mask with some alignment mark right over here which you cannot see from there it is impossible, but the point is there is a glass it can be chrome mask; it can be a chrome mask.

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Now let us see one more mask. So, we can clearly distinguish what I mean by bright field and dark field mask. This is another mask here right. What you can see? You can see there are two patterns on the bottom which are transparent remaining field is dark remaining field is dark right, but here on the two bottom you can see some patterns are there. So, this is your dark field mask, this is your dark field mask. It can be use as a mirror just kidding. So, we have bright field mask and we have a dark field mask.

You know guys in fab lab you are wearing a gown and everything you can see your face in this just kidding do not do that. So, this is your bright field mask this is your dark field mask very easy to identify, no it is very easy. So, both are 4, both are 5 inch mask. So, coming back to the screen, photoresist positive negative mask bright field dark field.

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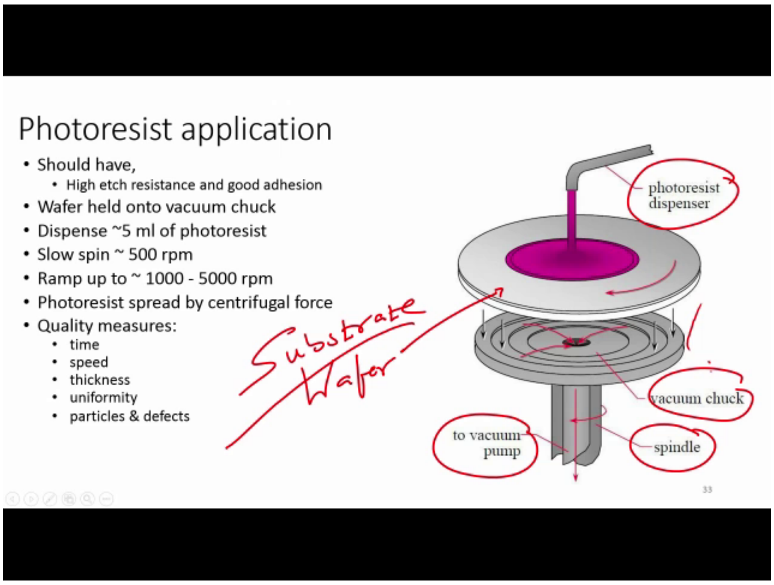

Photoresist application

- Should have,
  - High etch resistance and good adhesion
- Wafer held onto vacuum chuck
- Dispense ~5 ml of photoresist
- Slow spin ~ 500 rpm
- Ramp up to ~ 1000 - 5000 rpm
- Photoresist spread by centrifugal force
- Quality measures:
  - time
  - speed
  - thickness
  - uniformity
  - particles & defects

So, how can we spin code photoresist onto a silicon wafer right? So, we need a vacuum chuck which you can see here, there is a vacuum chuck right. There is a vacuum pump this; this goes to the vacuum pump two vacuum pump, there is a spindle there is a spindle which spins right and we said in starting there is a vacuum chuck here.

Now here the vacuum would be created, here in this area centre. This is the waferwe can also say substrate substrate right and substrate is holded onto this vacuum chuck with the help of vacuum and once it is attached or holded through vacuum, then we start dispensing photoresist. So, there is a photoresist dispenser. So, once the photoresist is dispensed, then we have to follow slow spin ramping up and once it is spin coded and it stops we can see time speed; the quality measures can be time speed thickness uniformity and particle size.

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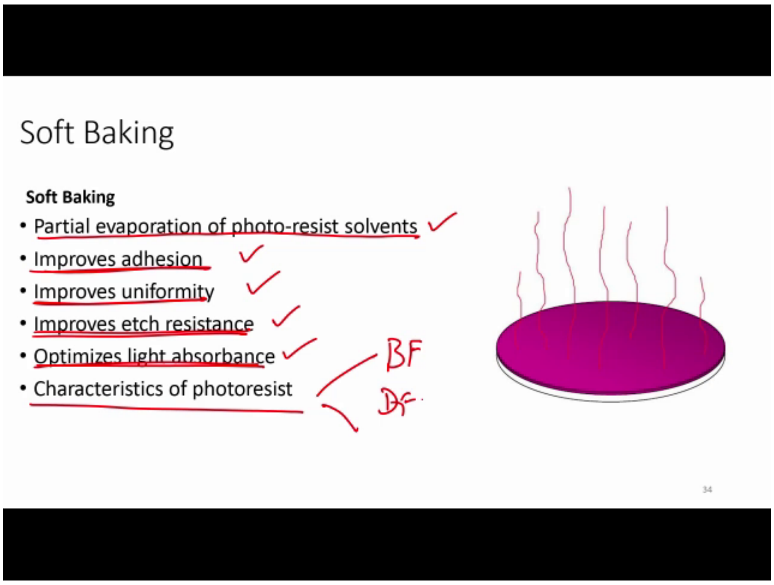

Soft Baking

Soft Baking

- Partial evaporation of photo-resist solvents ✓
- Improves adhesion ✓
- Improves uniformity ✓
- Improves etch resistance ✓
- Optimizes light absorbance ✓
- Characteristics of photoresist

BF

DF

So, if you remember the steps in photoresist is first easier after spin coating there is a soft bake soft bake like I said 90 degree; 1 minute depending on type of photoresist, 1 minute or what on hot plate. So, soft baking when we perform, what is the advantage of soft baking, what is the advantage of soft baking? First is partially evaporation of photoresist solvents, second is it improves adhesion, third is improves uniformity, fourth is improves etch resistance, then optimize light absorbance; finally, characteristics of a photoresist. Of course, it is a characteristic of photoresist.

So, optimized light absorbance improves etch resistance uniformity, improves adhesion and partially evoporation of photoresist solvents. So, characteristics of photoresist can be defined if depending on is it bright field photoresist, is it dark field photoresist and also what kind of mask you use.

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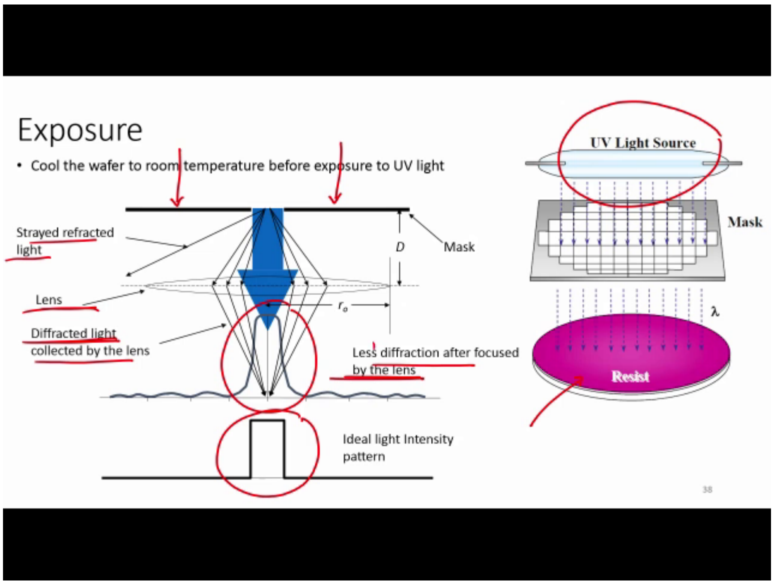

Exposure

- Cool the wafer to room temperature before exposure to UV light

So, now we know what is the advantage of performing soft baking. After soft baking, we had to align the mask, First is load the mask and then align it with the spin coated wafer right. So, when you align, the mask after what you performed perform? UV exposure so, you should have a UV light source; you should have a UV light source. The ideal intensity pattern should be like this; however, the intensity on the wafer the, UV intensity on the wafer is somewhere like this. How it is how it happens?.

There are few is a mask to the mask when the UV light passes through there is a straight refracted light for there is a lens here and through the lens, the life is deflected and collected by the lens right which falls on the UV. So, less difference deflection after focused by the lens right, it falls on the photo resist coated wafer and it cannot pass through the dark area. It can only pass through the bright area. It cannot pass through dark area; it can only pass through light area. What cannot pass? UV light cannot pass, UV light cannot pass.

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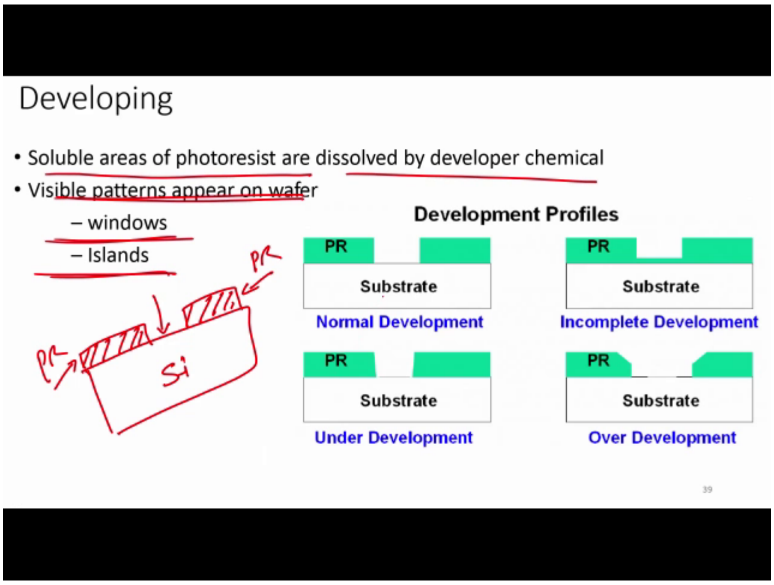

Developing

- Soluble areas of photoresist are dissolved by developer chemical
- Visible patterns appear on wafer
  - – windows
  - – Islands

Development Profiles

PR Substrate **Normal Development**	PR Substrate **Incomplete Development**
PR Substrate **Under Development**	PR Substrate **Over Development**

So, after the photoresist is exposed in UV light like I said depending on the foot. So, after that depending on the mask n type of photo resist will obtain different pattern right. So, how can we obtain? By developing photoresist in photoresist developer; so, the soluble areas of photoresist are dissolved by developer chemical visible patterns appears on the wafer right either windows or islands whatever we have designed whatever we have designed right. Suppose we are designing on the wafer some electrodes, then these are some islands. These are some valleys right or we are creating a pattern like this which is your photoresist, then this area we want to etch; this is your photoresist, this is your silicon. We want to etch silicon right. So, this is a window that you are created a window that you are created. We will take an example in later class. So, when you develop the photoresist, it is a normal development you will get pattern which is shown here.

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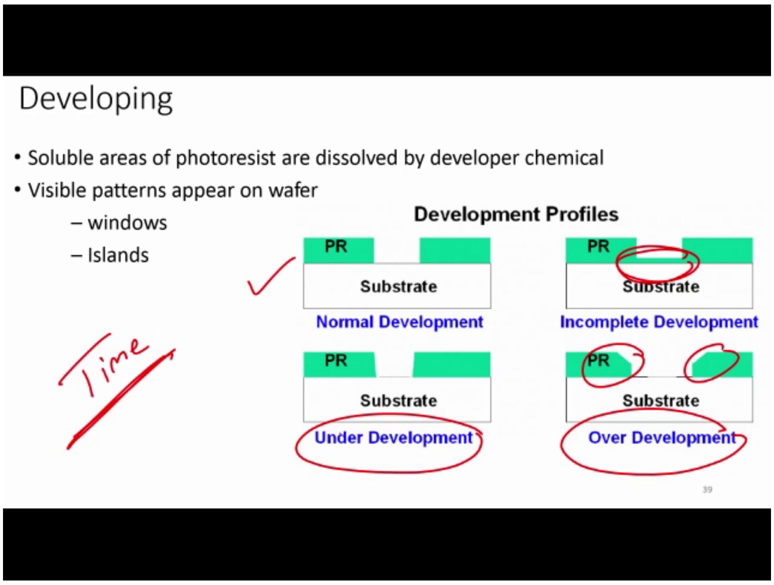

Developing

- Soluble areas of photoresist are dissolved by developer chemical
- Visible patterns appear on wafer
  - windows
  - Islands

However, there is under development, then you will get the kind of pattern. It is incomplete development you can see here, it is over development then you will see this structure. So, the time is very crucial, the time to develop the wafer in the photoresist or develop the photoresist in the photoresist developer is very important is crucial and if you exceed the time, then there is a over development. Sometimes there is an incomplete development, if you take out the wafer before time and then can be under development.

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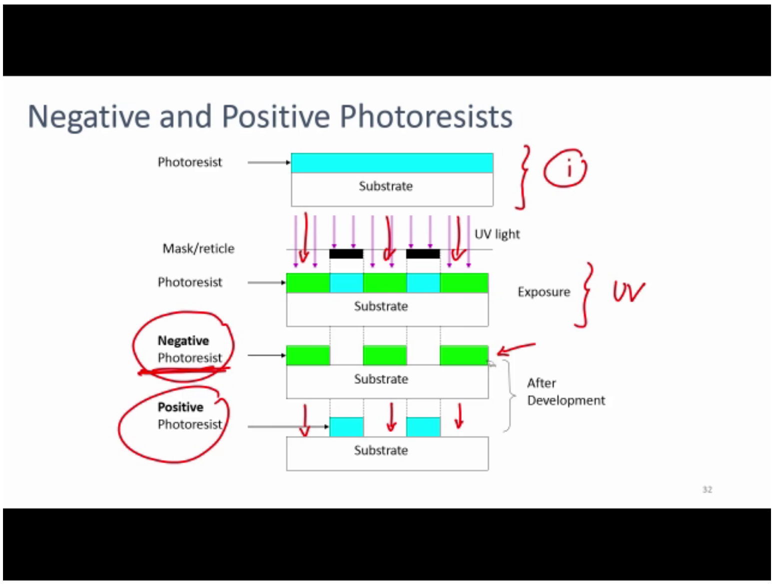

Negative and Positive Photoresists

Having said that let us see negative and positive photoresist examples right, which we have just seen, but in form of schematic. So, if I have a substrate and if I coat this substrate with a photoresist, I have a mask here a mask here. You can see the there are two dark areas remaining there a bright field; it is a bright field mask or let us assume it bright field mask. Now, if I expose this wafer if I exposed wafer number 1, with UV light right then if it is a negative photoresist if it is a negative photoresist, the area which is exposed you see the area which is this one, this one, this one exposed will be stronger you can see here right. The area which is exposed is stronger in case of negative photoresist.

While in case of positive photoresist, the area which is exposed becomes weaker; you see the area which is exposed becomes weaker. Area which is exposed by UV light right that area the photoresist this will get developed; if it is a positive photoresist, you got it easy right very easy right. It is a negative photoresist and positive photoresist it is very easy to understand, what will happen if I use a particular photoresist.

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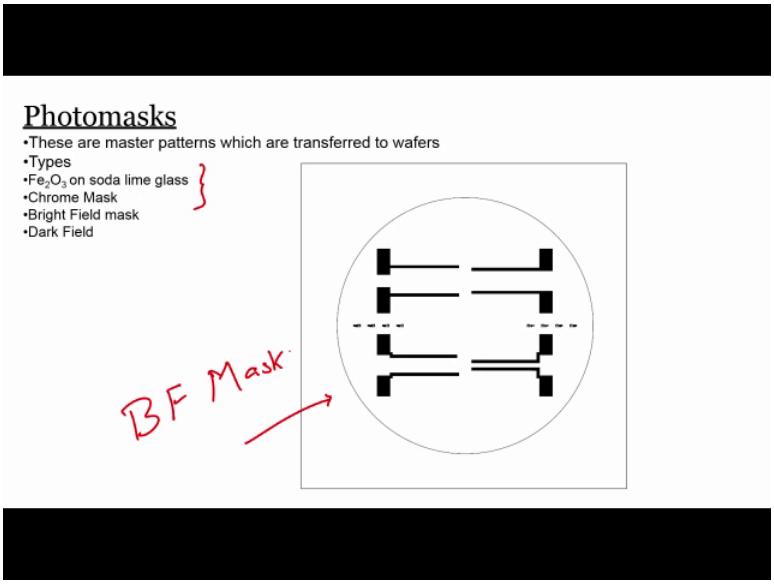

Photomasks

- These are master patterns which are transferred to wafers
- Types
- Fe_2O_3 on soda lime glass
- Chrome Mask
- Bright Field mask
- Dark Field

We have just seen masks adjust in few masks and these are master patterns which are transferred to the wafers. So, when you talk about types of masks, we have Fe 2 O 3 on soda lime glass, we have chrome mask. These are two different materials while the masks can be classified as brightful masks or dark full mask. This is an example of, this is an example of bright field mask guys.

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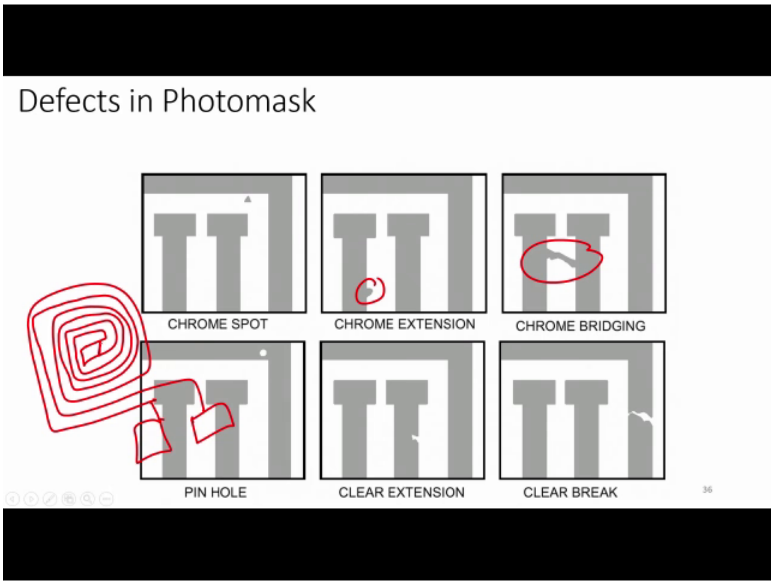

Defects in Photomask

Now, when we talk about masks, there can be defects in photo mask, defects in photo mask. What are those defects? First defect that you will see is a chrome spot. Now for us we do not care when we are going to make a bigger structure when we are going to fabricate a bigger structure, but when you talk about MOSFETs, then within this area there can be thousands of MOSFET right.

So, we are losing those MOSFET s if we have the chrome spots. If we have chrome exchange, we will not have correct results; if we have a bridging and if I am going to make a heater, it will be short right. If I make a heater let us say and if there is a bridging this is a short, this resistance would be different or let us say you have either like this right and if I have shot here, then it is gone correct. So, chrome bridging is not acceptable.

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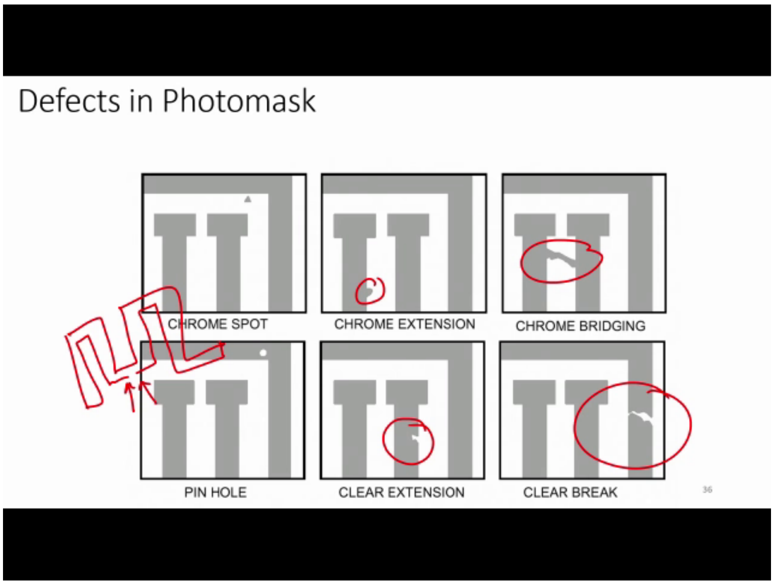

Defects in Photomask

Next pinhole, chrome is not there at all not allowed, then clear extension you see, clear extension not allowed right because the value that we you calculate and value when you use this mask would be totally different. Next is clear break, breakage is at all not allowed right. If there is a break let us say, if I make a this pattern right and if there is this is a break then it is not to correct right. The design itself will give us a different value if there is a break in them. So, these are few defects that you need to understand, I need to observe whenever you start working with a photomask.

So, this is a video interesting video where you will be able to see the mask aligner and it is an automatic mask aligner. So, I will play the video. Look at it, it is a front to back alignment and it is very interesting to see this mask aligner, then let us talk after the videos that are here to follow and then we will discuss for another 5 minutes to see what we have learnt.

Hello my name is Bernhard 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.

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Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

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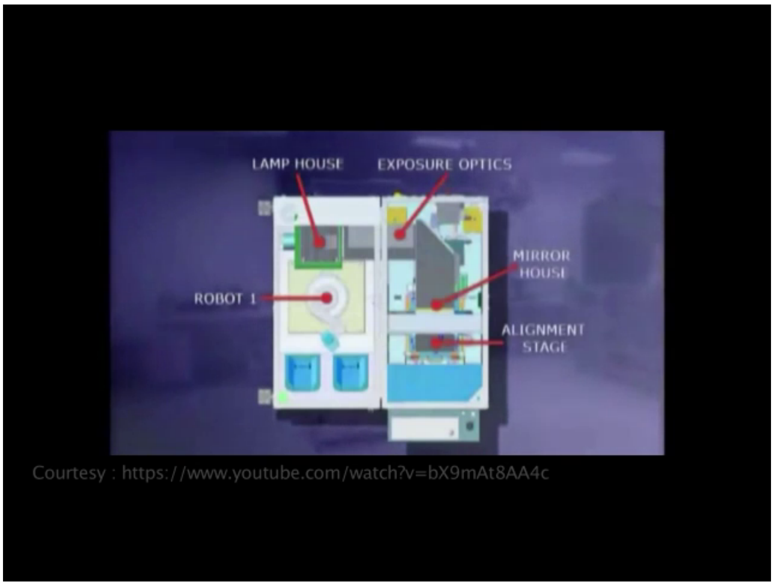

Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

See for yourself how easy it is to operate. The chuck is stored in the bottom part of the aligner and is quick and easy to load, equally easy to insert are the mask holder and the mask.

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Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

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 touchscreen.

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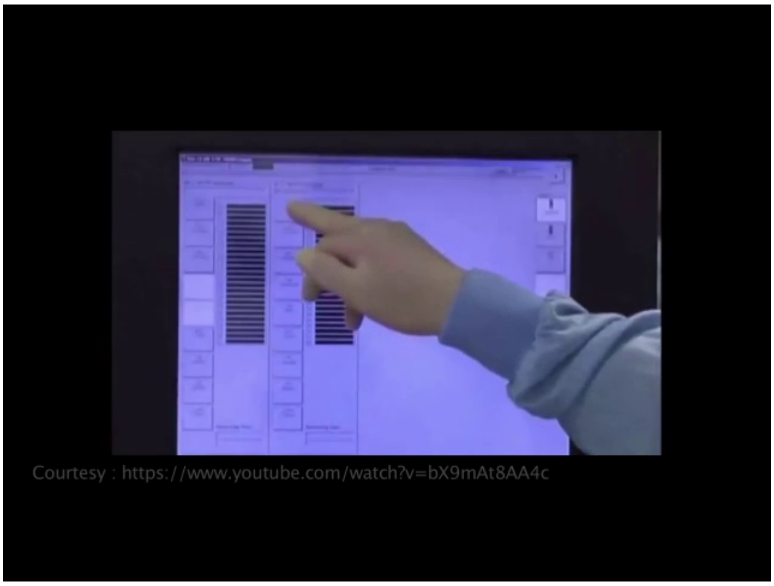

Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

For some processes, you can select between fully automatic and manual operation. A robot scans the wafers and determines their quantity, position and size and the processing begins. The MA 200 compact processes wafers and substrates up to 200 millimeters regardless of their material, size, shape and thickness. The machine runs and adjusts fully automatically, and is optimized for the processing of thick resists such as with thick resist, left ship bumping, wafer level packaging, MEMs, nanotechnology or telecommunication devices.

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Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

The big advantage over 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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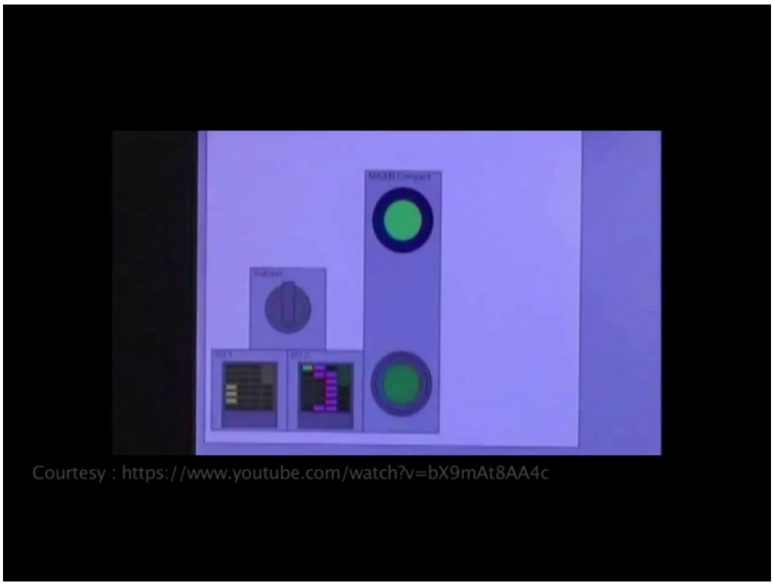

Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

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. The mask is aligned directly to the wafer, guaranteeing and overlay accuracy of up to 0.5 microns at 3 sigma. The structures of the photo mask are conveyed via shadow cast. The patented wafer leveling system from Suss compensates 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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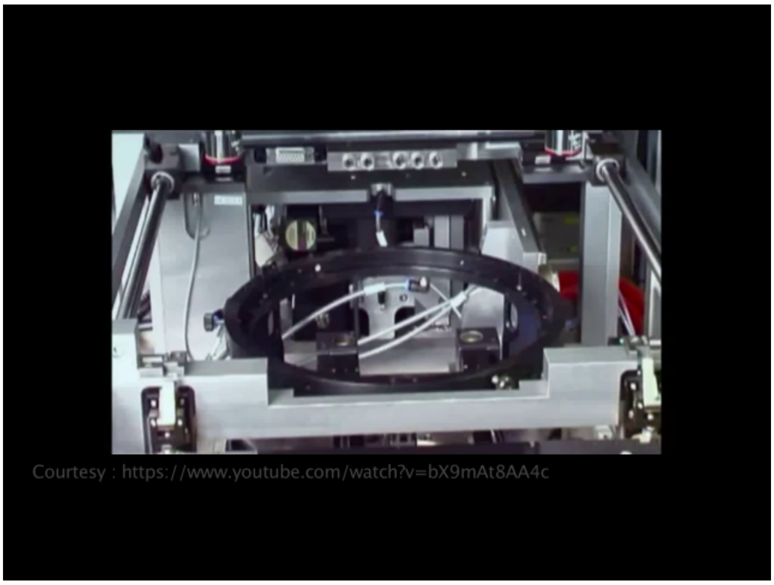

Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

Because of the MA 200 compacts newly designed microscope, during exposure the mirror housing does not move forward, the microscopes only move sideways. Thus reducing the vibrations of the alignment stage to a minimum, resulting in far greater accuracy. The optics of the MA 200 compact are optimized for thick resist processing and then resists it achieves a resolution of 3 microns in proximity mode and a sub micron resolution in contact printing.

A microscope for bottom side alignment is optionally available. It can process substrates with thicknesses of up to 4 millimeters. The MA 200 compact, here is a master when it comes to detail. No idea while designing, it was to create a device that is both user and maintenance friendly, in order to further reduce your operational costs.

(Refer Slide Time: 49:39)

Courtesy : https://www.youtube.com/watch?v=bX9mAt8AA4c

The electronics and all important components are easily accessible as well as being arranged in a clear and logical manner, because of its compact size, it also saves valuable space in the cleanroom. The MA 200 compact is the ideal exposure system for application areas with high demands in terms of package densities and micro mechanical 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.

Let us it is another video and again this is on the Karl Suss MA 6 Mask Aligner SOP. How to use a mass aligner; this is a video on this.

(Refer Slide Time: 50:45)

Please refer to the SOP documentation for further information on the procedures covered in this video.

To view the SOP documentation, click on the link located in the video's description area.

Courtesy : https://www.youtube.com/watch?v=sl1-5-EviR0

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So, let us see this video and then let us discuss.

(Refer Slide Time: 50:49)

Courtesy : https://www.youtube.com/watch?v=sl1-5-EviR0

This is the MA 6, it is used to expose our UV light to a substrate that has are either photoresist on it. So, before we learn the machine, the first thing we got to do make sure the light bulb is turned on or even I have done enough. So, we come out to the back and you can see the lights turned on by the recession here or you can see the light glowing.

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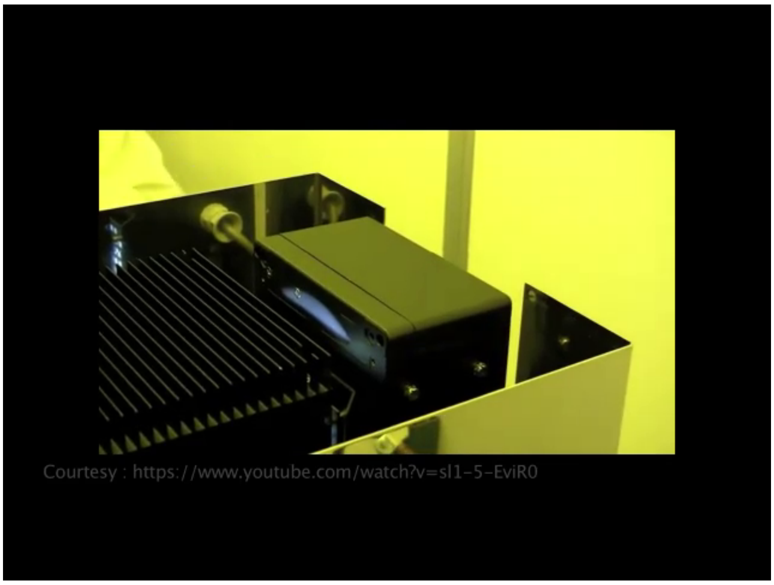

So, you know that on the light bulb is on, but in addition to that we want to find out how many hours are left on the light bulb. So, you check the power supply.

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So hold this button 4 gs and it says 3226; it is how many hours the bulb is being used. So, the bulb has a lifespan of 4000 hours. So, when it is over 3500, we would notify staff and tell them to change it. So, were pretty close to that. Now that the bulb is to use and there is nothing wrong with a bulb and the power supply. If you want to log into the system so before we login, we check the logbook.

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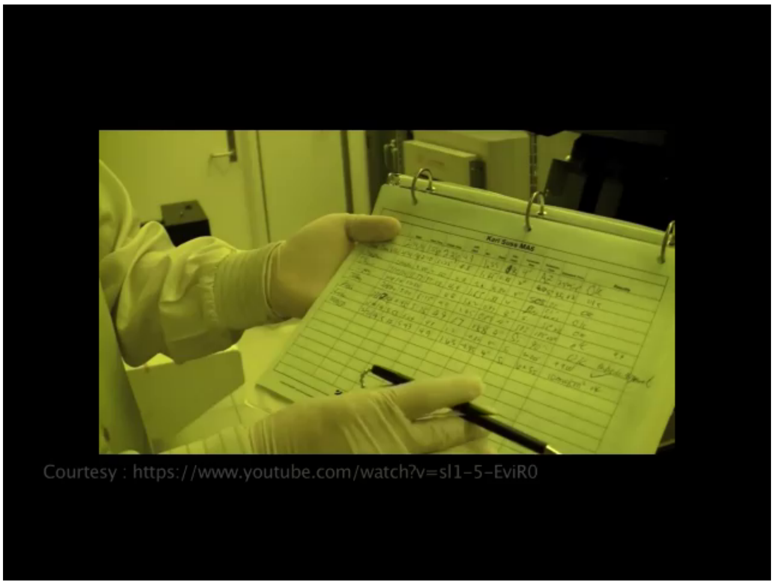

Courtesy : https://www.youtube.com/watch?v=sI1-5-EviR0

The logbook would say that the last person who used this was Monika and 2:21. And (Refer Time: 52:03) check note she had anything was wrong. So, you can see there is nothing wrong. So, were ready to turn the machine on and login. Say in the login computers, here you have to login to use the machine that otherwise would not turn on and the Login has a several functions, the first screen is the login, there type the username and password.

If you schedule to use a machine and there is an hours, you should check this to make sure nobody else is using it. So, today is 24 and it is 10 AM and nobody is using it. So, therefore, you use it. Also there is a history tab, there we can see the last user, then you can see that Monika was last user and she is last one to write a logbook. So, what is going on the machines already and (Refer Time: 52:55) we just login. So, once you have logged in the machine, we will be able to power up and what we do now is we turn the on switch on here.

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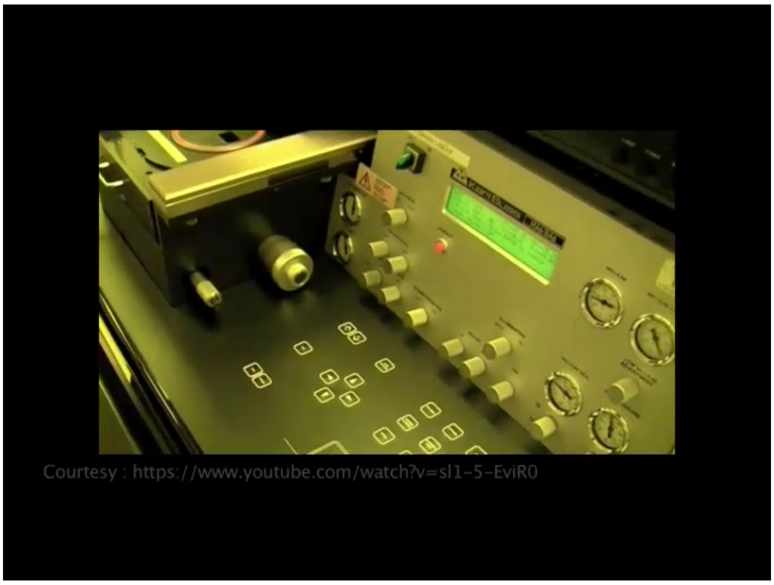

Courtesy : https://www.youtube.com/watch?v=sI1-5-EviR0

So, we just turn it to the on switch, now you can see the machine starting up; and it is important to read the screen it tells you a lot of information. So, it says ready for start, press load button, so the load button is right here, we will press that; now it says watch out machine is starting up. You know when the machine is ready for load and started up; (Refer Time: 53:31) says ready for load. So before we want machine does (Refer Time: 53:36) one thing we can do is change the parameters, say hit this button called edit parameter.

So, now, even you can adjust the parameters such as time and distance and type of exposure. So, how do we edit the parameters or change the difference from this p is the x left and right. So, we move this way, we change the gap, change the type of contact and then change exposure type. So, let us change the exposure time first. So, it says 5 seconds now.

Now we can change it to 25 seconds. If you hold fast and up, you can change it faster. So, it is a 25, let us make it 26. Now we want to go slower so, we do not hit fast we just. So, now, we have adjusted the exposure time. Let us change the lighting gap; let us make that 40 and let us change the well make a soft contact; (Refer Time: 54:39) I have changed. There is different type of exposure types some soft, vacuum, hard supplemental to get more information right now well stay in the soft. So, once your parameters are set you can hit edit parameters. What going to do now is load the mask. So, how do we know the mask? Press the button to change mask on the screen.

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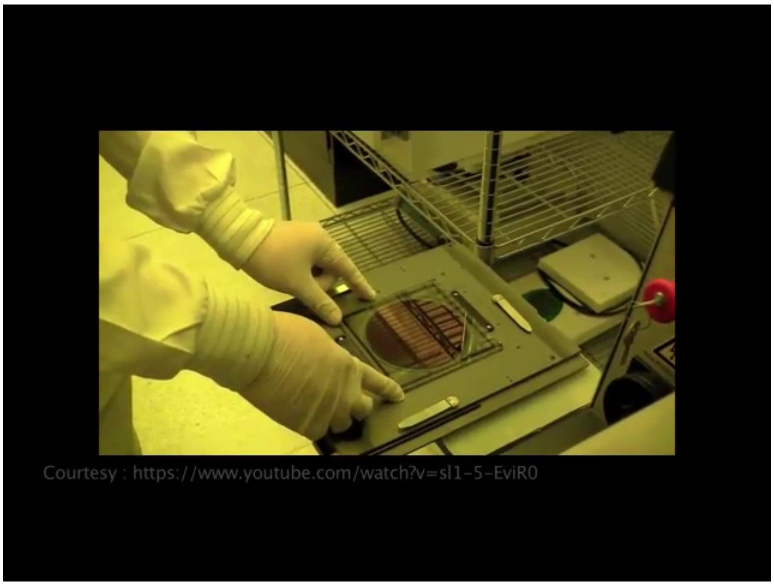

Courtesy : https://www.youtube.com/watch?v=sl1-5-EviR0

So, we hit change masks already below the mask. So, (Refer Time: 55:10) here. So, you load your mask in here by lifting this clip here and putting it in and (Refer Time: 55:20) you hit this button called enter you could (Refer Time: 55:24) the vacuum. So, right now the vacuum is off, when you press enter now the vacuum is on. And when you come back, you can see that its vaccum there is stuck very well. So, now, were going to put this in here.

So, we carefully carry it, place it all the way in and when it is in we press change a mask and that is how you load your mask. We are going be doing the backside alignment now. So, what this does is it aligns features in their back of your wafer; to your mask and how we do it is (Refer Time: 56:08) microscope from the bottom. So, first thing they do is, we have to have our mask loaded and then we turn the screen on and we make sure this thing says backside linemen microscope is on. So, it is on, but also we need to change this to backside alignments. So, it can be their tops alignment or it can be a backside alignment. So, this is an elimination.

So, now, the light is coming from the backside. So, if you look in here you can see the light hitting the features say that is the microscope from here coming looking up yet. So, they can look for those on the screen now, and pretty much what you do is this controls the microscopes in the back. So, you can select one at a time and move around till you find your features it looks like we found (Refer Time: 57:04) on the mask. So, we need adjust the focus so, use this top straight left and right. So, the left one just the left; the right one will adjust the right focus, we 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 right I and then I will move it up and down. If I want to (Refer Time: 57:34) move the left one, it is a similar thing. So, can you find your mask and you think you are ready to do exposure an alignment you had grab this image same press, grab image button right here and then you press that what it does it; it takes a picture of the mask. Now were ready to load the wafer, we press this button says load wafer says this side and substrate onto to check, we will just load our wafer on and when it is in we press enter and it will bring it up.

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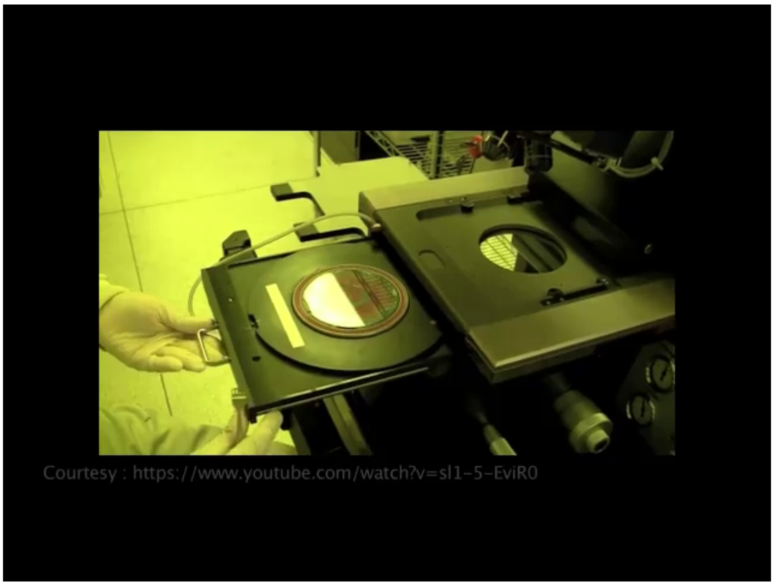

Courtesy : https://www.youtube.com/watch?v=sl1-5-EviR0

So, now you can see you are in contact, this is the image overlay from the mask and these features right; here so that they define the bottom substrate on your wafer.

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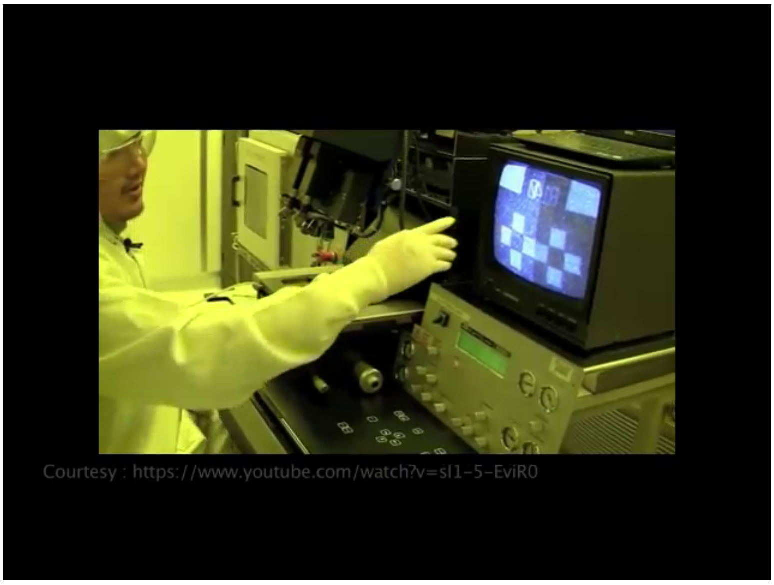
Courtesy : https://www.youtube.com/watch?v=sI1-5-EviR0

So, how do you move the wafer? We know that these buttons will move microscope wafer, its these ones right. It is these knobs right here. This is y, this 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, this image is moving and then you can see this moving. So, this is the y position on the left side and the right side is the x knob, you can adjust the tilt with the (Refer Time: 59:22); and how you can adjust the focus? You can adjust the intensity or light. So, you would do that to find your alignment marks and then align them.

So, once you have aligned them they are ready for exposure, then how do you expose? You press the, first you align and check which should bring it up, such you want to make sure nothing moved and then when it is in contact you hit exposure and then when you do exposure is good to turn your back away from the light. So, it does not damage your eye, so hit exposure and then we just turn away.

So, after exposure under a wafer so, then what you do is you come to a screen, then it will say pull slide to unload (Refer Time: 60:14) substrate. So, you just pull it out and then this is the press enter button and then the vacuum will be released, then you can take your wafer out the menu you put it back in. So, that is how you unload your wafer after exposure. What we are going to do now is topside alignment by using the microscope on the top to aligne to the wafer that is underneath to the glass.

So, to do tops our alignment, we need to move the backside microscope. So, we press this button that turns it off, also we need to put the illumination into the top side and then we can load our wafer in. So, again you press load, it says this slide and load substrate onto chuck; then we press enter (Refer Time: 61:32) then the microscope automatically come down because we have the BSA microscope light button off. So, now, it is down we will turn the TV screen on and what this is doing is taking the image from here onto the screen. So, again this these buttons right here control the accent of my position of the microscope.

So, let us say you found something here. So, we can turn out its pretty the power of illumination is pretty high intensity. So, if you lower the power then you can see that. So, little find the mask lyman left on this side. So, there is different features on this, this knob right here. So, if you move it just to control the light microscope x position of the light microscope so the left side has the same button, so when I know the left knob I can turn this light, then I move the right knob I can turn it this way. We can adjust the tilt to make this match up by turning this knob right here. So, they look like it is pretty matched up.

So, what you do is you do the same thing as a backside alignment align, your lighting locks on your wafer to this right here. So, you can see that if I move this so, these knobs control the substrate. So, I move this you can see that this has been moved. So, you can tell that is the actual substrate moving, not the mask. So, you try to focus it and you try to find your alignment marks, then align them to the features. And then once you have alignment that you do the same thing when you do alignment check and I will bring the mask up and then we expose it.

So, you press expose and then you do expose. So, now you turn away. So, the UV light does not hit your eyes. So, after your double exposure you would unload your wafer so, it tells you first slide to unload substrate. So, you pull it out and then you would take it out. Now, you finish the sample and put this back in. Now if you are done it, you want to move this back up and you do not want to bring it back down this is where you press the PSA button. So, by default this will now come down, also to bring this up, you press F1 and enter and that would bring the microscope up. It is always good to leave it in this position with the microscope up and the BSA button on because that way microscope does not come on and off every time you are using it.

So, after that were ready to take out our mask. If you want to unload the mask you press the change mask, it is pretty similar to loading it. So, reverse process so you press change mask, it would take the substrate out, hit the enter button to remove the vacuum and then you take your (Refer Time: 65:07) mask out. You press the change mask button again and they will say confirm with enter as you know the mask is there. So, now, already we would turn the system off.

So, well make sure everything is in the standby position, then you started the machine and then before you turn it off, you want to make sure you write into the logbook 2000 parameters. So, the compressed air is about 4.9, nitrogen is about 4.65, the vacuum is about 0.86, taking the 0.86. We use a full inch of wafer and silicon that we did 25 second exposure. Now were going to turn off this thing, we do is we turn off the switch here, yes on the TV screen and then we can log out here. And its a message did you reset the xy tilt position, then we did that so we put ok.

So, if you now see what we have learned, what we have learnt? If you can see, I will show it to you on the screen here. I have in something in my head, what we have learned today is a step called photolithography. The step called photolithography. In the last two videos, what you guys have seen? One is a automatic mask aligner, you have to load the wafer; it will perform everything a robotic arm will take the wafer and then it will perform the photo lithography. In the second one, you have seen how can you perform front to back alignment, how can you align the wafer higher to align the mask, what is a procedure.

The idea is to fabricate simple things, simple devices like the one that I am holding in my hand or complex devices such as MOSFET or devices that can be used for clinical application like our drug screening device, that will be talking about in the lectures to follow right.

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Drug screening device, will look similar to what I am holding right now in my hand. This device can be used for rapid drug screening; that means, that if a person comes with the cancer to a doctor, where the doctor has to decide which drug he has to or she has to give to the patient and which will work out. But unfortunately there is no patient centric platform that a doctor can try the recognition can try before giving it to the patient. That means, what I am saying is if you take the cells from the patient, you lower the cells onto this device, you flow the drug, you get the results and tell which drug would be effective for this particular patient.

Can you fabricate this kind of device? The answer is yes; how? By understanding photolithography, right. So, we will be looking at such kind of devices and such kind of interesting platforms that can be used for rapid drugs screaming. Why I said rapid scanning because there are multiple channels here and a single in a single shot, we can perform 8 different drugs we can screen using this platform or we can check 8 different patient samples with single drug. So, such kind of applications we can use it using the micro engineering platform and understanding the photolithography.

So, just go through this particular module and try to understand try to focus and see what things we have been discussing in this module and if you have any questions feel free to ask me in forum and either me or my TA would reply to your queries. Let us see very interesting applications of this micro engineering devices in the classes to follow. Till then you take care, have a nice day bye.