Sensors and Actuators
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Lecture - 12
Fabrication Process Flow of Microheater and Micromachining

we will learn photolithography.

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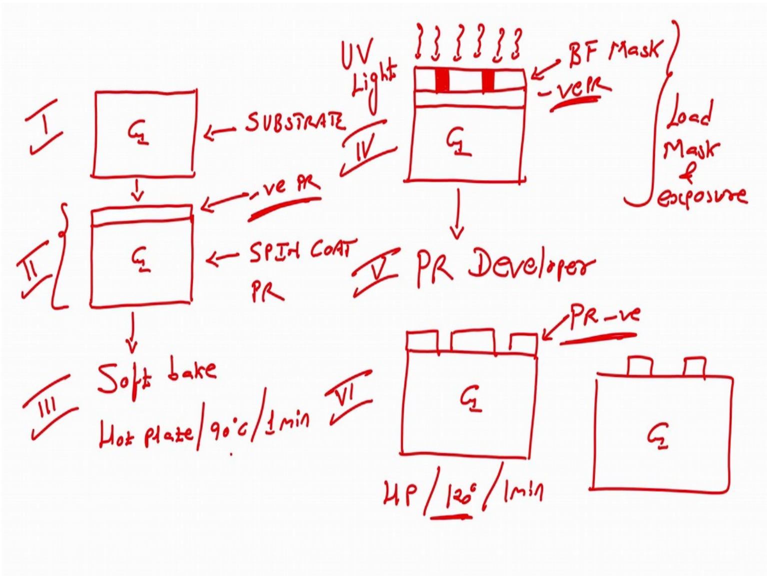

The first step is to take a substrate it is assumed that is silicon and have to deposit a metal, the substrate is an oxidized silicon wafer. If you are using glass no need of oxidizing a glass because glass itself is an insulator. on glass next step is to spin coat; spin coat photoresist. We can use positive or negative photoresist. In this case, using a positive photoresist.

Next step is to spin-coated the photoresist on the substrate. The next step is to perform a soft bake. Soft bake is similar to baking. Soft bake means load this wafer on a hot plate the temperature of the hot plate is 90-degree centigrade and the time that will load the wafer on the hot plate will be 1 minute this called soft baking. Next step after this is have to load the mask.

Next will load a mask,this mask is the bright field mask. Positive photoresist glass bright field mask. Then align the mask The next step in this is have to unload the mask.

And after unloading the mask the next step would be a photoresist developer so will dip this wafer in a photoresist developer. Positive photoresist. the unexposed region will be stronger.

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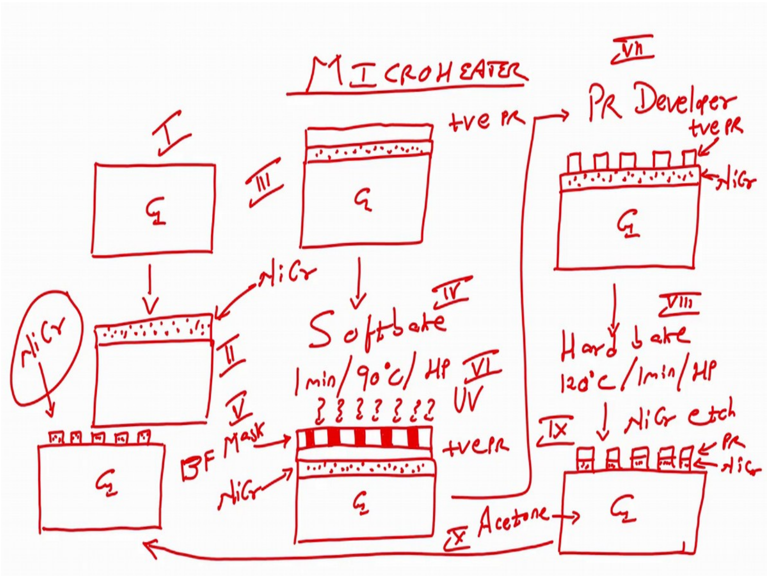

The process of making microheater.it is called Micro heater because the width and the spacing between two lines are of micron dimension.

The first step in making microheater is to take a substrate then to deposit a metal example, nichrome. Next step after this, on the nichrome, spin coat positive photoresist Next step is soft bake. Soft bake is done at a 1-minute with temperature 90-degree centigrade and are using hot plate. The next one is have to take this wafer we have our material which is nichrome on that have positive photoresist; on this positive photoresist we will load a bright field mask, bright field mask has a pattern. next step is perform UV exposure after this will dip the wafer in a photoresist developer The area which is not exposed becomes stronger and the area which is exposed will become weaker. The next step is Hard bake, is done at 120-degree centigrade for 1 minute on hot plate. The next step is will dip this wafer in nichrome etchant this is wet etch where dip this wafer in nichrome etchant will have nichrome only in the area; only in the area which was protected by the photoresist the remaining nichrome will get etch in the nichrome etchant wherever photoresist was there that photoresist will act as a mask and it will protect the nichrome below it. The remaining area the photoresist will get etched After this will dip this wafer in acetone. It will strip off photoresist

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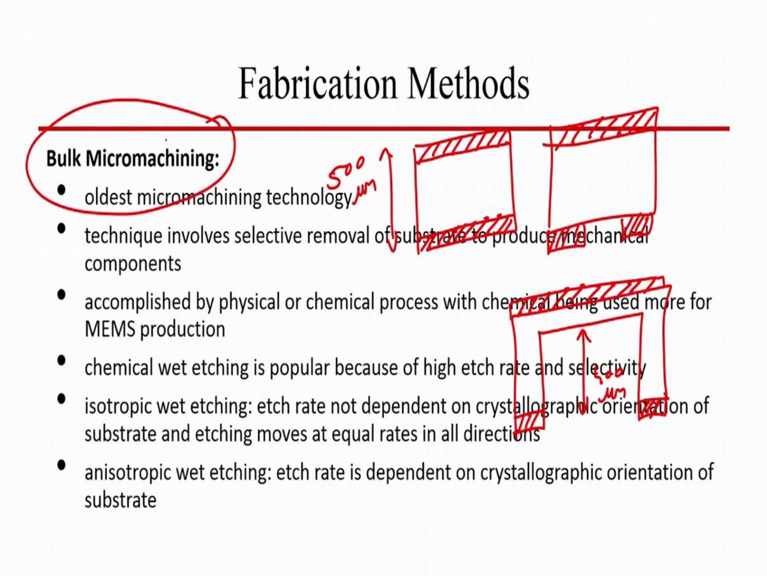

another very important step is bulk micromachining and bulk micromachining is where you take out the bulk of the material for example, the silicon substrate oxidize silicon substrate and to create a diaphragm in this oxidize silicon substrate, then have to create a window from the bottom; that means, have to etch the silicon dioxide from the area where want to etch the silicon wafer. etch this wafer so, as to create a diaphragm.

So, a bulk part of it is removed is etched or is machined and that is why it is called bulk micromachining So, this is an example of bulk micromachining and it is the oldest micromachining technology involve selective removal of a substrate to produce mechanical components.

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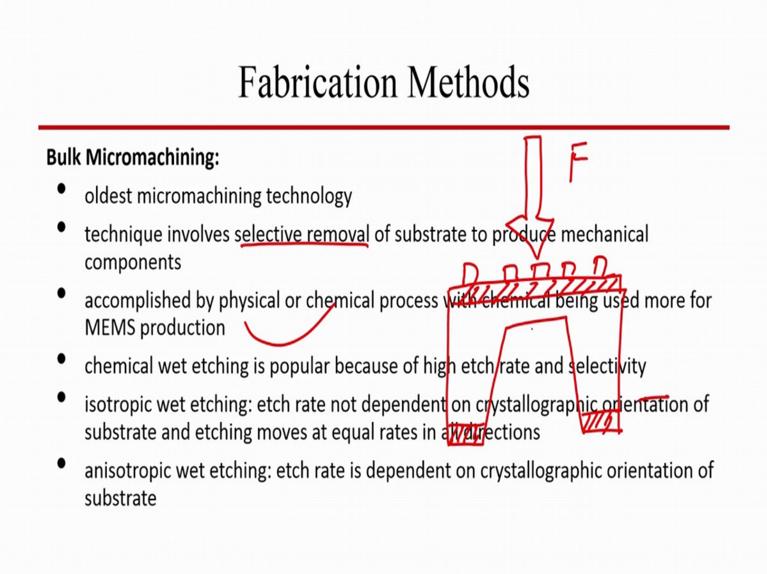

So, if have silicon dioxide which is protected by silicon guard dioxide will not get etched. Only silicon that was not protected by silicon dioxide when created a window will get etched.

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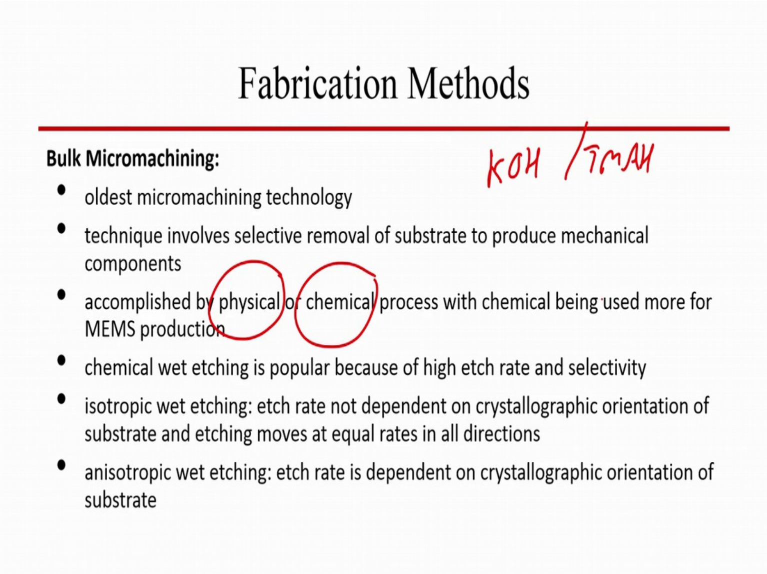

So to etch the silicon wafer will use potassium hydroxide these are both chemicals. So, the chemical being used mostly when are going to fabricate MEMS-based sensors. The chemical wet etching is popular because of the high etch rate and selectivity. Isotropic wet etching where etch rate not dependent on the crystallographic orientation of substrate and etching moves at equal rates in all the directions while there is anisotropic etching, where etch rate is dependent on the crystallographic orientation of the substrate.

In dry etching and wet etching, you have isotropic etching and anisotropic etching and where the anisotropic etching would be depending the crystallographic orientation while in the case of isotropic wet etching, it does not depend on crystallographic orientation and etching moves at equal rates in all the directions.

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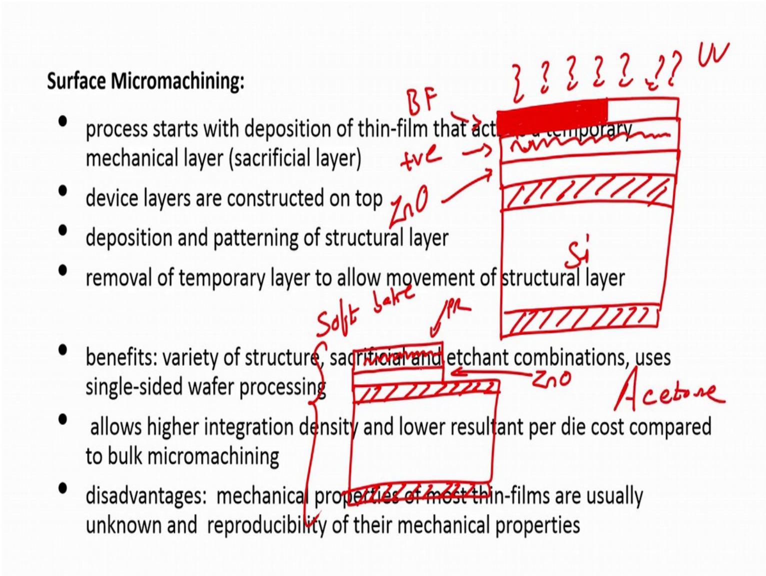

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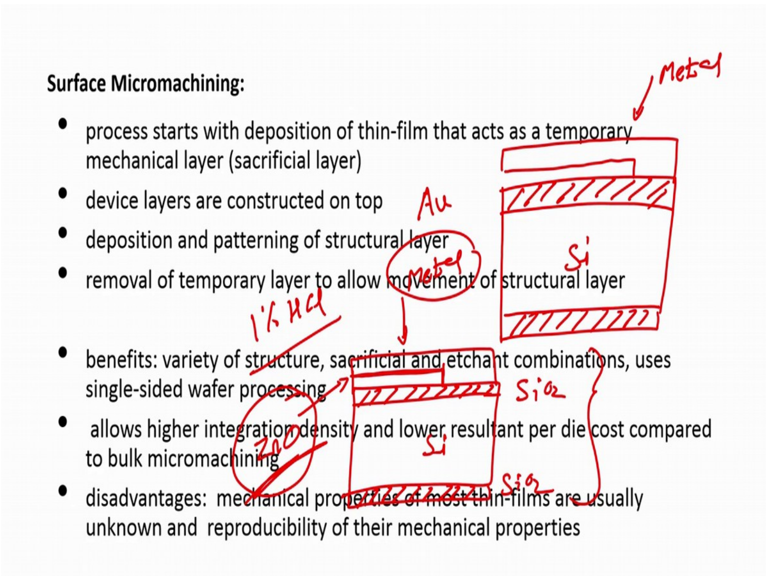

Now on this zinc oxide deposit metal and dip this zinc oxide in etchant after depositing metal, dip this zinc oxide, this silicon wafer the oxidize silicon wafer with metal into zinc oxide etchant then the zinc oxide will get etched. Zinc oxide etchant will not affect the metal which is example gold. Zinc oxide etchant is 1 percent HCl. 1 percent HCl will etch zinc oxide it will not etch gold this way able to see a cantilever able to fabricate a cantilever and everything that have seen here is machining, but the machining is done at the surface level. have not etched any bulk part of the material bulk part of the substrate So, everything is done at the surface level and that is why the machining that we have done at surface to create this cantilever of a metal which is gold than this is called a surface micromachining technique and the zinc oxide layer that we etched to create this cantilever, that zinc oxide is called a sacrificing layer or sacrificial layer. The layer that are sacrificing to create them; to create the cantilever so, as called a sacrificial layer .This is an example of your surface micromachining. The process starts with a deposition of a thin film that acts as a temporary mechanical layer called the sacrificial layer right. Then the next step is the devices layer are constructed on the top, for example it was metal, depositing and patterning of such a layer removal of temporary layer to allow movement of structural layers will create a cantilever, it can vibrate The benefits of this particular technique are a variety of structures are possible to build sacrificial and etchant combinations are there, uses single side wafer processing.

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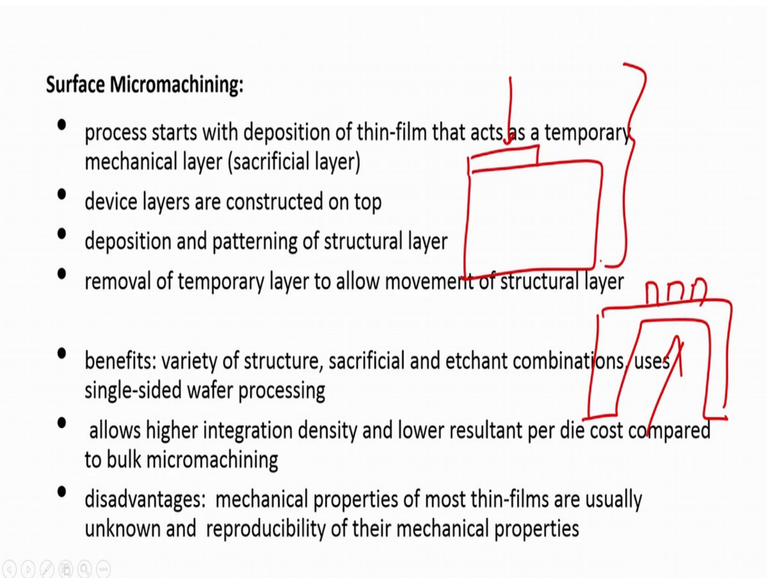

If want to create a diaphragm on the backside; creating a structure also etching from the backside. In this case require a wafer which is double side polished, in this case, can use a wafer which is a single side polished, So, if it is a single side polished the cost of fabrication will be less compared to a double-side polished wafer. Then the further advantage of surface micromachining is let it allows higher integration density and lower resultant per die cost compared to bulk micromachining; that is an advantage and the disadvantage or limitation is that the mechanical properties of most thin films are usually unknown and reproducibility of the mechanical properties is kind of difficult right. So, that is another point that need to understand that the mechanical properties of most thin films are usually unknown, and the reproducibility of their mechanical properties is important.

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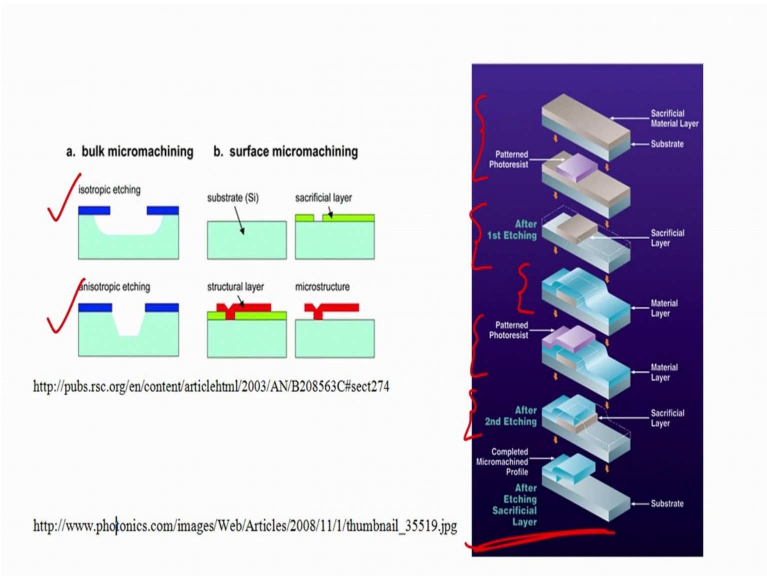

So, if this as an example of the bulk micromachining and surface micromachining, in bulk micromachining there is isotropic etching and then there is an anisotropic etching. In surface micromachining, the first step is that have a substrate, then have a sacrificial layer that pattern it, then deposit a structural layer finally, sacrifice the sacrificial layer right in this particular form. So, have the cantilever.

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