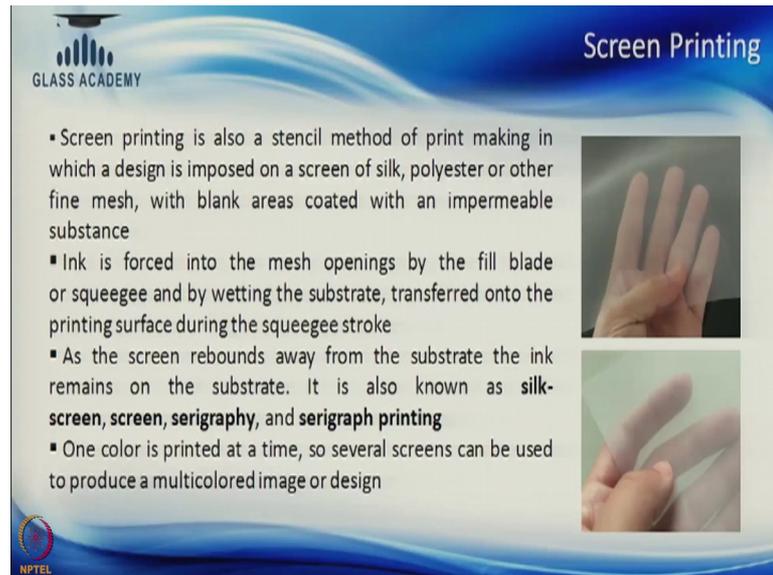


Glass Processing Technology
Prof. Pranit Malik
Department of Civil Engineering
Indian Institute of Technology, Madras

Lecture - 61
Ceramic Printing on Glass

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Screen Printing

GLASS ACADEMY

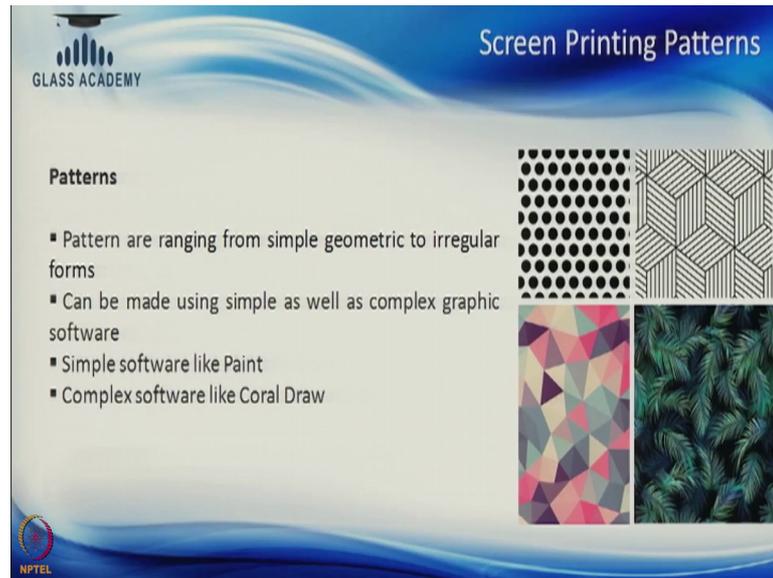
- Screen printing is also a stencil method of print making in which a design is imposed on a screen of silk, polyester or other fine mesh, with blank areas coated with an impermeable substance
- Ink is forced into the mesh openings by the fill blade or squeegee and by wetting the substrate, transferred onto the printing surface during the squeegee stroke
- As the screen rebounds away from the substrate the ink remains on the substrate. It is also known as **silk-screen, screen, serigraphy, and serigraph printing**
- One color is printed at a time, so several screens can be used to produce a multicolored image or design

NPTEL

Then we will come onto screen printing which is quite popular, because it is a very versatile process. The process of printing on glass using silk screens is called screen printing, screens can be from other materials as well. It is essentially a stencil method of printing where you impose a design on the screen and that design is then passed onto the glass certain sections of the silk mesh will become impermeable or the ink will not be allowed to pass.

And there would be other sections where the ink can pass. So, the design is made in such a way that the areas where the ink can pass, the design goes through and the other areas the ink cannot pass through. So, you take a rubber squeegee and you run it through the silk mesh and the ink will flow through the transparent areas.

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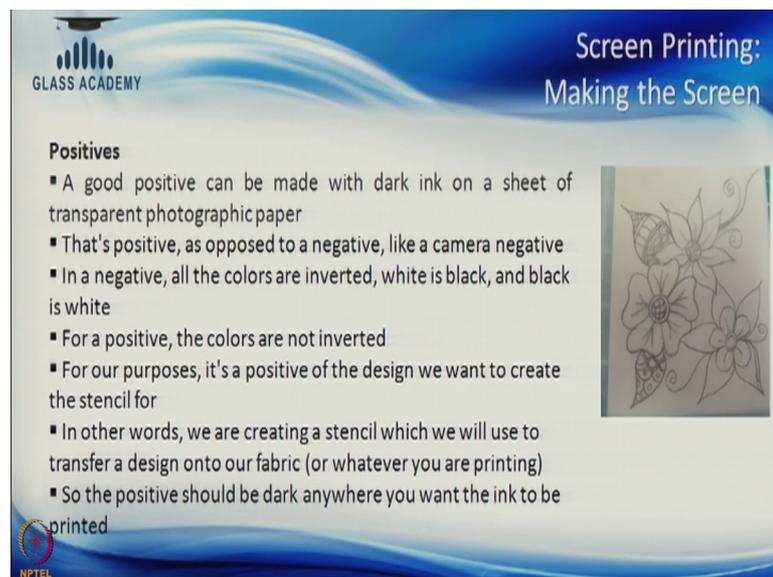
Screen Printing Patterns

Patterns

- Pattern are ranging from simple geometric to irregular forms
- Can be made using simple as well as complex graphic software
- Simple software like Paint
- Complex software like Coral Draw

So, it is a long process to do screen printing. And it starts with making the screens. The screens have to be made with the positive in mind. It is not a negative it is a positive I will explain in the next slide. So, you can print patterns designs with screen printing you can even do multicolour prints. So, you can use a simple or complex software to make these prints and you can have many options that you can achieve.

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Screen Printing: Making the Screen

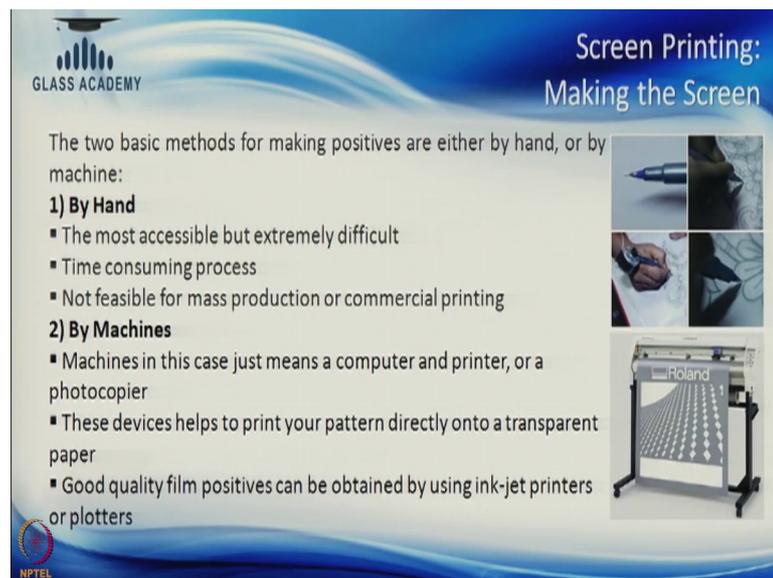
Positives

- A good positive can be made with dark ink on a sheet of transparent photographic paper
- That's positive, as opposed to a negative, like a camera negative
- In a negative, all the colors are inverted, white is black, and black is white
- For a positive, the colors are not inverted
- For our purposes, it's a positive of the design we want to create the stencil for
- In other words, we are creating a stencil which we will use to transfer a design onto our fabric (or whatever you are printing)
- So the positive should be dark anywhere you want the ink to be printed

So, you have to make a positive to begin with. A good positive is made with the dark ink which does not let the light pass through it on a transparent sheet or photographic paper.

So, the positive is different than a negative. A camera negative is where the colours are inverted; in this case it is not so. In a positive, the colours are not inverted essentially the dark portions are the ones which will block the light; and these are the areas where the ink will pass through. So, the area where you need the ink to pass through need to be dark that is why it is called a positive, and not a negative. We will go through the process of making the positive.

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GLASS ACADEMY

Screen Printing: Making the Screen

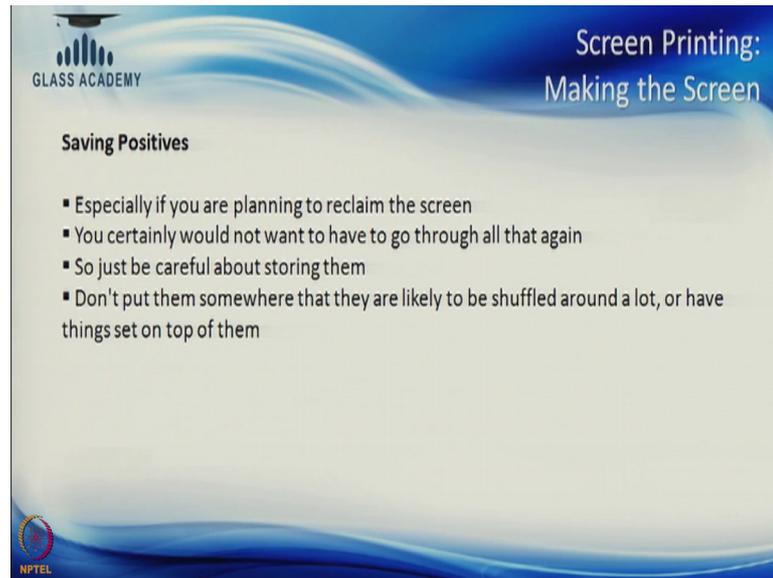
The two basic methods for making positives are either by hand, or by machine:

- 1) By Hand**
 - The most accessible but extremely difficult
 - Time consuming process
 - Not feasible for mass production or commercial printing
- 2) By Machines**
 - Machines in this case just means a computer and printer, or a photocopier
 - These devices helps to print your pattern directly onto a transparent paper
 - Good quality film positives can be obtained by using ink-jet printers or plotters

NPTEL

You can make a positive by hand as well; there are several artistic people who want to create art by doing this by hand. As I explained positive is nothing but putting a black ink on a photographic paper. So, you want to block the light that is going through, but more often the not it is done through machines there are a lot of printers white format flat jet printers available, where you can make your patterns and then transfer it onto these transparent sheets, where the accuracy can be maintained. And good quality films are available to do so.

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GLASS ACADEMY

Screen Printing: Making the Screen

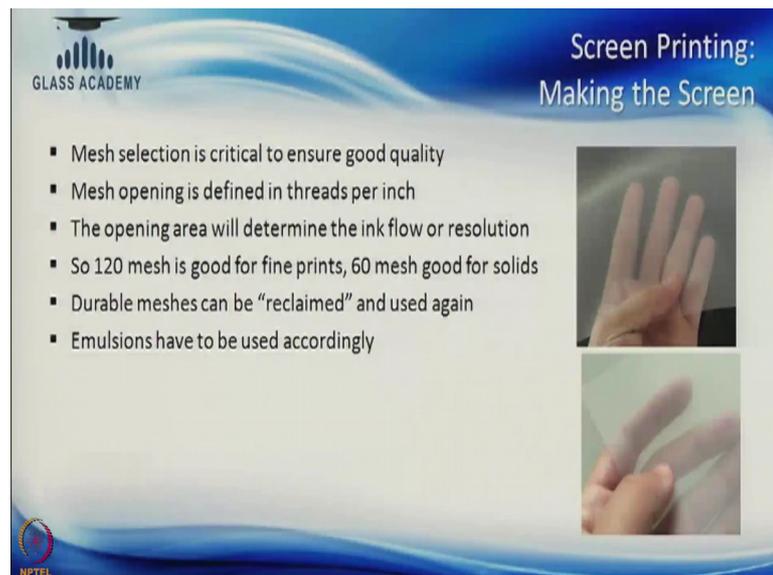
Saving Positives

- Especially if you are planning to reclaim the screen
- You certainly would not want to have to go through all that again
- So just be careful about storing them
- Don't put them somewhere that they are likely to be shuffled around a lot, or have things set on top of them

NPTEL

It is also important to save the positives now positives cost a lot of money. These are wide format positives not easy to match many positives together such as an offset printing. So, it is essential to have a good storage area for the positives. And in certain cases you can have the same design go onto the same screens again and again. So, you need to be able to use the positive again. So, make sure that you use a good film, and you have good storage conditions for the positives.

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GLASS ACADEMY

Screen Printing: Making the Screen

- Mesh selection is critical to ensure good quality
- Mesh opening is defined in threads per inch
- The opening area will determine the ink flow or resolution
- So 120 mesh is good for fine prints, 60 mesh good for solids
- Durable meshes can be "reclaimed" and used again
- Emulsions have to be used accordingly

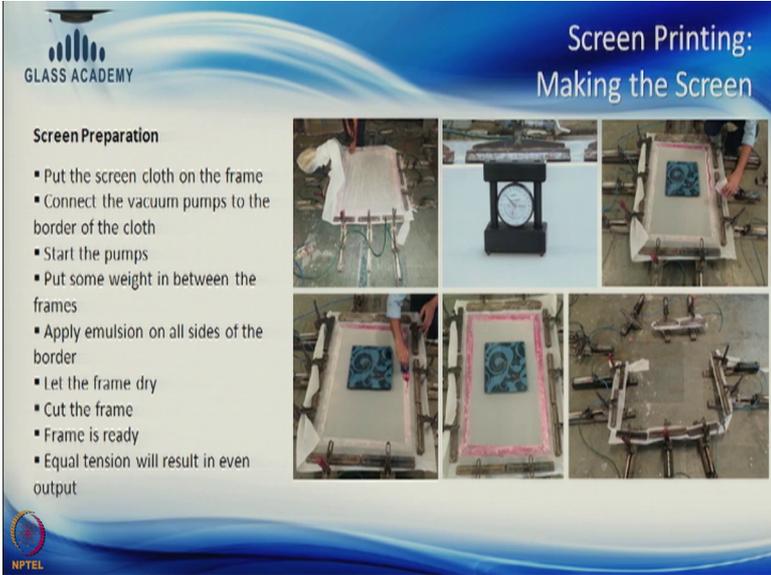


NPTEL

When we start the screen printing process, we have to select the mesh. So, the mesh selection will depend on the pattern that you are going to print. So, certain patterns will have a very fine print, and there would be others which have large solid areas or areas where there is a lot of ink that needs to be transferred. So, based on the design pattern you have to select mesh, the mesh can be measured in lines per inch which is essentially how many threads are going in an inch and which will determine the resolution of the print that you are going to do.

The more the number of threads are the lesser amount of ink will be deposited through them, that means, if you have got a 120 mesh that means, there are more threads per inch you will have a finer print and less ink will go through; and if you have a 60 lines per inch, then more ink will go through this will also mean that different thing will not be that sharp. So, it is always a balance. So, you have to choose the mesh according to the pattern that is being printed. So, there is no one size fits all kind of a condition. You have to have various mesh sizes available different bits available in order to get the right results.

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GLASS ACADEMY

Screen Printing: Making the Screen

Screen Preparation

- Put the screen cloth on the frame
- Connect the vacuum pumps to the border of the cloth
- Start the pumps
- Put some weight in between the frames
- Apply emulsion on all sides of the border
- Let the frame dry
- Cut the frame
- Frame is ready
- Equal tension will result in even output

NPTEL

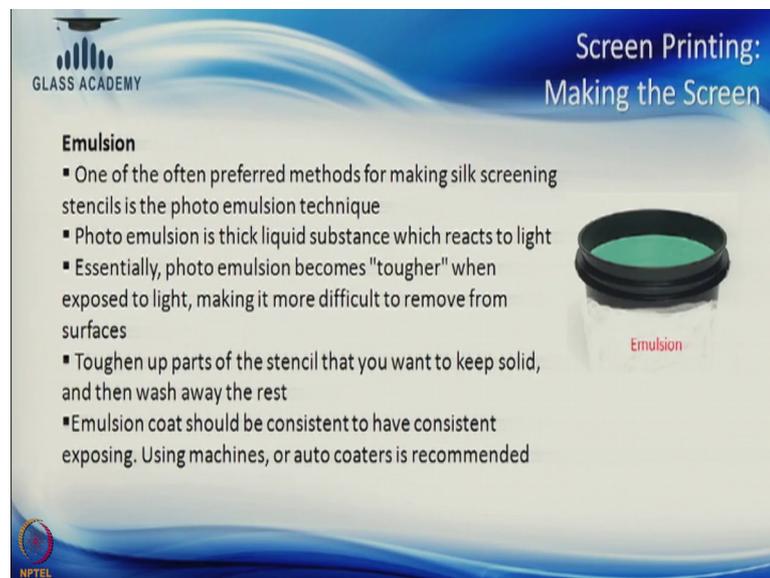
The slide features six photographs illustrating the screen preparation process: 1. A person stretching a white screen cloth onto a metal frame. 2. A close-up of a vacuum pump connected to the screen's border. 3. A person applying a blue emulsion to the screen. 4. A close-up of the screen with the emulsion applied. 5. A close-up of the screen with the emulsion applied. 6. A close-up of the screen with the emulsion applied.

So, the first process is the mesh selection then you essentially prepare the frame. So, you put this mesh that you have selected on an aluminum frame we have used a wide aluminum frame because we want to hold it together well. And what we have used is a series of pistons which will stretch the fabric or the mesh in such a way that there is even

distribution of tension on the glass. And this will result in an equal opening area all across the frame. If the opening area of the frame is not the same across the length and the width of the frame, you will have more and less ink deposition on different areas, one of the tools which is showing measurement of the tension on the cloth.

So, you have to measure that in the center and on the sides the tension is the same. Once you stretch the cloth, you apply what is essentially a glue to paste it with the frame and then you let it dry and achieve a even amount of tension and then you cut it through and you get the frame ready. So, even an equal tension is the key for this process and having a wide aluminum frame will always help. If you have got rod or a pipe kind of a frame, it will bend. So, do not save money on the frame because that will affect the screen printing. I have seen a lot of wooden frames a lot of frames which use pipes this will essentially flex in the middle, and you will get an uneven print, the lines will not go straight. So, if you want the lines to go straight use a thick aluminum frame, and place the screen on it. So, you get a equal tension and equal pressure on all sides.

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GLASS ACADEMY

Screen Printing: Making the Screen

Emulsion

- One of the often preferred methods for making silk screening stencils is the photo emulsion technique
- Photo emulsion is thick liquid substance which reacts to light
- Essentially, photo emulsion becomes "tougher" when exposed to light, making it more difficult to remove from surfaces
- Toughen up parts of the stencil that you want to keep solid, and then wash away the rest
- Emulsion coat should be consistent to have consistent exposing. Using machines, or auto coaters is recommended

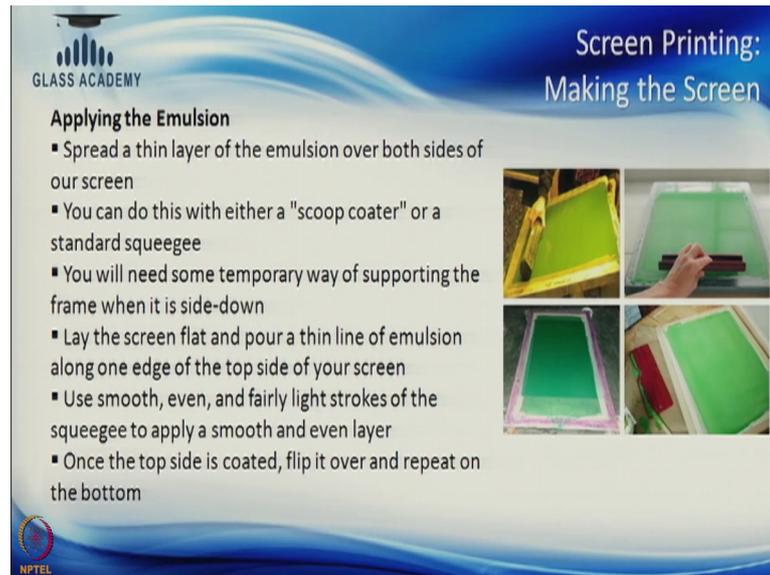
Emulsion

NPTTEL

Then you have to coat what is light sensitive or a photo emulsion is something which blocks the screen and this particular emulsion is light sensitive. So, wherever light touches the emulsion, the emulsion will become hard; and wherever the light does not touch the emulsion the emulsion will wash away. So, the purpose of the emulsion is to create the positive or create the frame where the ink will pass through the areas where

the positive that you just made, black portions will not get the light and the other areas which will get the light will solidify. So, you have to coat the emulsion evenly on the frame and it has to be consistent because if it is not consistent, it will not during the exposing process. It will solidify at different times. So, we will come to the exposing part and we will understand this a little bit more.

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GLASS ACADEMY

Screen Printing: Making the Screen

Applying the Emulsion

- Spread a thin layer of the emulsion over both sides of our screen
- You can do this with either a "scoop coater" or a standard squeegee
- You will need some temporary way of supporting the frame when it is side-down
- Lay the screen flat and pour a thin line of emulsion along one edge of the top side of your screen
- Use smooth, even, and fairly light strokes of the squeegee to apply a smooth and even layer
- Once the top side is coated, flip it over and repeat on the bottom

NPTEL

So, first you have to apply the emulsion. You spread a thin layer of the emulsion on both sides of the screen this can be done with the scoop coater and you can have automatic machines to do it. For smaller frames that may not be essential, but for larger frames where manual coating may not be consistent, so their machines are important. And process is easily explained in the slide that you coat it and support it side down. And you have to pour a thin layer of emulsion on it there are various kinds of emulsions available, and the coating thickness is also mentioned according to the emulsion.

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GLASS ACADEMY

Screen Printing: Making the Screen

Applying the Emulsion

- Make sure to cover entirely both sides of the screen, any holes you leave will allow ink to get through
- The edges are particularly prone to this, and will cause stray lines of ink to show up on your print
- Do the best you can, and remember that on the top of the screen (the printing side, or flat side), you can extend the emulsion over the edge of the screen onto the frame, if that helps seal those edges



NPTEL

The slide features a blue header with the 'GLASS ACADEMY' logo on the left and the title 'Screen Printing: Making the Screen' on the right. The main content area is white with a blue wavy border at the bottom. It contains a section titled 'Applying the Emulsion' with three bullet points. To the right of the text is a photograph showing a person's hand using a brush to apply a thick green emulsion to a yellow screen frame. The NPTEL logo is in the bottom left corner.

This is another image of how the emulsion is coated. The edges are prone to leave any holes or gaps if you have any gaps in the emulsion, then the frame will be compromised. So, this is telling you that you have to take care that all throughout the frame the emulsion has to be coated even on the edges; otherwise you will have some ink go through areas where you do not want it to go through.

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GLASS ACADEMY

Screen Printing: Making the Screen

Drying the Screen

- Make sure you dry the screen in a dark location, exposing it to light now will cause over exposure and ruin your stencil
- Other alternatives are to fashion an opaque box big enough to fit the frame in
- Your screen will take varying amounts of time to dry, depending on the emulsion, the thickness of the coat and the air conditions
- A small fan blowing gently across it can help speed things up if you can arrange that
- Once it is dry, it should not feel sticky at all
- Also keep in mind that the top of the screen will generally dry faster than the bottom; be sure to check both sides before removing



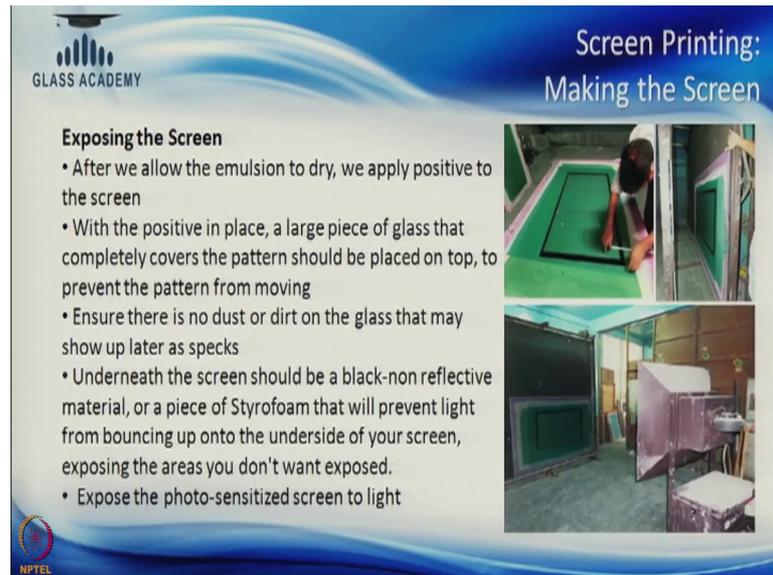
NPTEL

The slide features a blue header with the 'GLASS ACADEMY' logo on the left and the title 'Screen Printing: Making the Screen' on the right. The main content area is white with a blue wavy border at the bottom. It contains a section titled 'Drying the Screen' with six bullet points. To the right of the text is a photograph showing a screen frame with green emulsion being dried inside a dark, rectangular box. The NPTEL logo is in the bottom left corner.

Once the emulsion is coated, you have to dry it in a dark location. So, you have to have a darkroom. Exposing it to light right now will mean that it will start to solidify. So, this is

essential you need to have a good darkroom, and you need to dry it with air if you have a few blowers going. So, the sooner it dries off the better and the thickness of the coat is important. So, once again you want to keep it flat you do not want it at an angle because if it is that angle it will flow through on one side. So, you dry it off and once it dried up, then you go onto the next process which is putting the positive on the frame itself.

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GLASS ACADEMY

Screen Printing: Making the Screen

Exposing the Screen

- After we allow the emulsion to dry, we apply positive to the screen
- With the positive in place, a large piece of glass that completely covers the pattern should be placed on top, to prevent the pattern from moving
- Ensure there is no dust or dirt on the glass that may show up later as specks
- Underneath the screen should be a black-non reflective material, or a piece of Styrofoam that will prevent light from bouncing up onto the underside of your screen, exposing the areas you don't want exposed.
- Expose the photo-sensitized screen to light

NPTEL

So, now we have already selected the mesh. We have already pasted it on the frame. We have coated with the emulsion. Now, we put the positive on top of the emulsion. So, we can put a large piece of glass on top of the positive. And as we seen in the image we then put it in vacuum machine, where air will come out and essentially the positive will stick on to the frame surface; and now it will be exposed to the light which is photo sensitized.

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**Screen Printing:
Making the Screen**

Exposing the Screen

- Different photo emulsions require different exposures
- Stronger lights will require less time to develop, perhaps as little as 15 minutes depending on conditions
- Using unfiltered UV black lights, it only takes 5 minutes



NPTEL

In the next process, you put the light onto the frame, and now the exposing times will vary according to the patterns will vary according to the emulsion that is being used. There can be exposing they are normally yellow in colour. So, there are various variations to the same, but essentially you expose the frame with light. And stronger light will take 15 odd minutes for the screen to expose. There are some UV lights as well which will speed up the process.

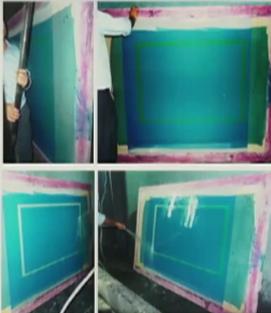
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GLASS ACADEMY

**Screen Printing:
Making the Screen**

Developing the Pattern

- Once the screen is properly exposed, you can remove it from the immediate light source and remove the positive
- As soon as the positive is removed, you should start washing it out (under normal indoor lighting conditions)
- This is done under regular tap water, nothing special required
- If the screen was exposed properly, the unexposed portions should begin to become visible almost immediately under a strong flow of water
- A little vigorous scrubbing with your finger tips will have it fully removed in 10 to 15 minutes
- Once the stencil is totally washed out and allowed to dry, you've got yourself a stencil, perfect for screen printing



NPTEL

Once the screen is exposed, you need to wash it. And you will wash the frame, the areas where the light has gone through to the emulsion will solidify. And the other areas where the light has not been able to pass through will wash off. So, this can be done with regular tap water. And you have to sort of check it with light if there are certain holes within the emulsion; you need to plug it right now that means if there are areas where you know for some reason the light has not gone through. So, there may be certain small holes which we need to touch up.

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GLASS ACADEMY

**Screen Printing:
Printing on Glass**

Printing

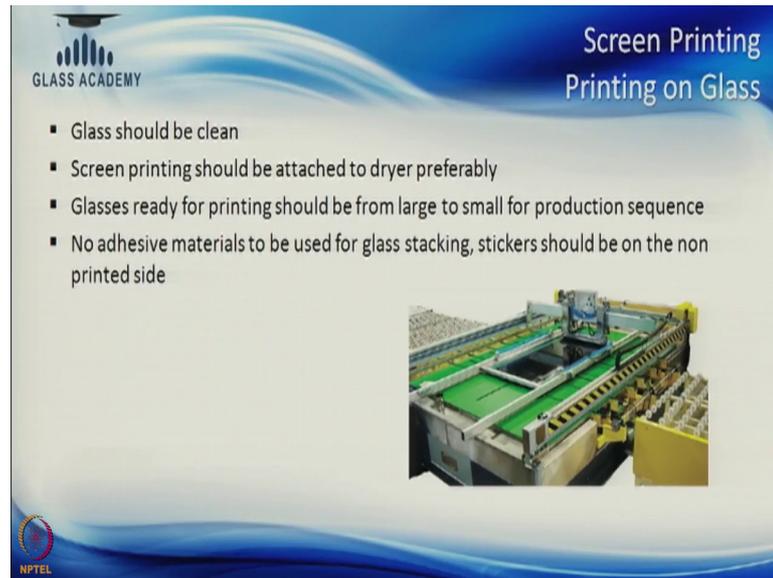
- A blade or squeegee is moved across the screen to fill the open mesh apertures with ink
- A reverse stroke then causes the screen to touch the substrate momentarily along a line of contact
- This causes the ink to wet the substrate and be pulled out of the mesh apertures as the screen springs back after the blade has passed
- This is suitable for solid colors and normal patterns like dots, squares, checks or lines in single color with repetitive designs

NPTEL

The slide features two photographs of a screen printing machine. The top photograph shows a long, narrow printing bed with a blue mesh screen stretched across it. The bottom photograph shows a similar setup from a different angle, highlighting the mechanical components and the ink reservoirs.

So, once the screen is ready, the transparent portion of the frame is where the inks will go through. And you have various printing machines where the frames go on. And you transfer this ink onto the glass surface with something called a rubber squeegee. The rubber squeegee is essentially hard rubber at a particular angle which will force the ink onto the screen and the areas where which are transparent, the ink will flow onto the glass surface. The pressure the speed and the angle of the print has to be consistent for a consistent print. The opening of the mesh has to be consistent for the consistent print. So, we recommend using machine. If you use a manual process the speed of application and the pressure may vary. So, you are not sure of the deposition of ink that you are making, and the deposition may vary according to the pressure that has been applied.

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The slide features a blue header with the text 'Screen Printing Printing on Glass'. In the top left corner, there is a logo for 'GLASS ACADEMY' and an NPTEL logo in the bottom left. The main content is a bulleted list of four points, followed by a photograph of a screen printing machine in operation.

- Glass should be clean
- Screen printing should be attached to dryer preferably
- Glasses ready for printing should be from large to small for production sequence
- No adhesive materials to be used for glass stacking, stickers should be on the non printed side

It is important note that glass should be clean after going through the entire process. If the glass is not clean, you will have problems when you are firing glass. Screen printing should be attached to a dryer as well, so be quicker you are able to dry the ink the better results you will get. Now, if you have various sizes of glass that you need to print, you need to go from a larger size to a smaller size. If you go from a smaller to a larger or you have a mixed up sizes, you will end up cleaning the screen many times. And more number of times you clean the screen, the screen will get damaged or it will take more time.

So, you go on for a larger size to a smaller size and these needs to be inbuilt into your system that the glasses that reach the printing process have to go in a particular sequence. The other thing that you need to take care of is that printed side of the glass when it has to be clean it does not have to have any glue that means, that the stickers that you are using or the labels that you are using to track the glass have to be on the non-printed side. Separators that I use in the process have to be without any gum or any glue and preferably on the non coating side and the handling has to be with gloves. So, these are a few basic things that need to be done. And you do not need to find out the hard way when your production surface.

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Summary:

By the end of this video, you have learnt about the:

- Screen printing - Making the screen
 - Mesh selection
 - Screen preparation
 - Applying the emulsion
 - Drying the screen

