Screen Making For Membrane Switches

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Printing membrane switches requires skill and control over the process. This industry has set fairly tight quality standards in regard to mechanical function and appearance and the requirements for this type of application are typically very high. Some of the critical parts of producing membrane switches are the control of color hue and density. This is achieved through the stencil, i.e. the mesh selection and stencil preparation. Changes in stencil quality will hence result in changes of total product quality.

This article explains what the critical areas in stencil making are and how to achieve consistent quality.

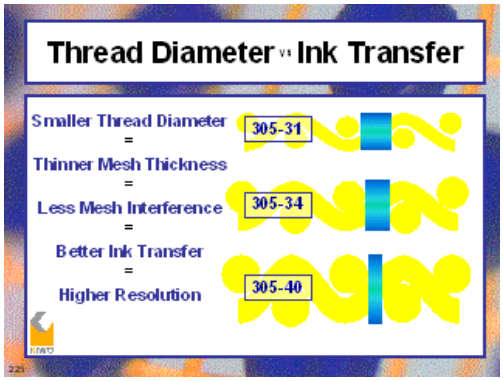
Typical Substrates for Membrane Switches

Transparent polycarbonate film is the most common substrate for membrane switches. Usually it is printed on the second surface (back side), but in some cases the first face (front side) is printed as well. The substrate can be glossy, matte, textured, metalized and even brushed. An important consideration for making the screen is the difference in surface roughness of the substrate.

Typical Substrates

A wide variety of mesh counts are necessary to print membrane switches. Fine mesh counts in the range of 260-355 threads per inch (tpi) are used to print the face panels. For conductive silver pastes, medium mesh counts of 172-230 tpi are common, and very coarse meshes in the range of 63-110 tpi are used for printing pressure sensitive adhesives.

Each mesh count is available in S, T, and HD grade. The difference between these grades is the thread diameter, which will affect the ink transfer and each may require different coating techniques to achieve the optimum print result.



Low elongation polyester fabric and stainless steel fabric is used to achieve high mesh tension and hence excellent registration in print.

Selecting the Stencil System

When selecting the stencil system, consider the following features:

- **Excellent copying quality**
- **Adjustable stencil build up**
- **Resistance to solvent and UV inks**
- **Possibly water resistance**
- **Length of possible print runs**

Several stencil systems are available for this application:

- **Indirect films**
- **Capillary films**
- **Direct emulsions**

Indirect films are fairly fragile and may not hold up for longer print runs. Their greatest disadvantage is the limitation to adjust the stencil thickness. These films have a predetermined thickness and id applied correctly, will only provide one possible stencil thickness on a given mesh count.

Capillary films are very well suited and are available in three different chemical systems:

- **Diazo films**
- **Diazo photopolymer films**
- **SBQ films**

Diazo films and SBQ films are limited in copying quality. However, SBQ films may be an alternative for coarse mesh counts where thick emulsion build up is necessary and a fast exposure time is helpful.

The best films are made from Diazo-photopolymer systems, which provide the best copying qualities and resolution. They also feature better chemical resistance.

One major disadvantage of capillary film is the limitation to given film thickness that may or may not produce the needed stencil build up. Typical film thicknesses are 18, 20, 25, 30, 35, 50 and 80 microns. Deviations from the recommended film thickness for a given mesh count may result in poor stencil quality.

If applied by the same person, capillary film stencils can be reproduced within a tolerance of plus or minus 2 microns. Better tolerances can only be achieved with automatic film applicators.

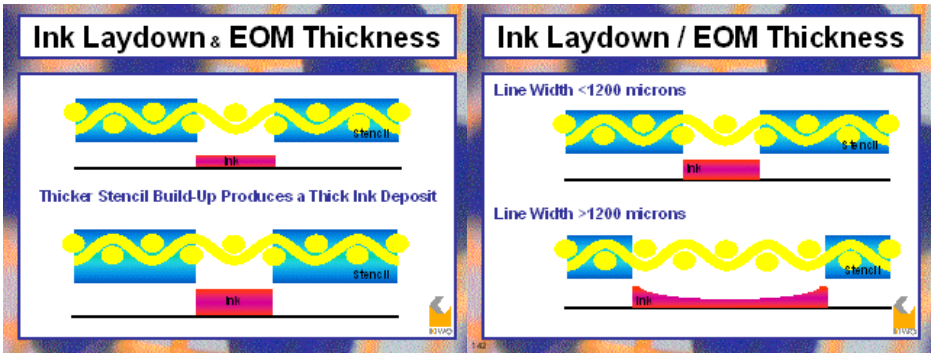
Direct emulsions are available in the same chemical systems of which Diazo-photopolymer emulsions are the best choice. They give the best copying quality and feature excellent chemical resistance. Direct emulsions also offer a high level of adjustability in all respects.

- Emulsion build up
- Viscosity
- Resolution
- Mesh bridging
- Chemical and mechanical resistance

For the variety of mesh counts and close tolerances in emulsion build up, a high quality emulsion with perfect mesh bridging, edge definition and resolution is required. The solids content of the emulsion should be in the range of 35 - 38 percent to enable slight changes in emulsion build up. The viscosity should be in a medium range of 5,000 to 12,000 mPas to assure good coating properties on all typical mesh counts.

Stencil Thickness – A Tool to Control Ink Density

Ink film thickness is one of the major quality aspects of membrane switches. The amount of ink transferred to the substrate is controlled through the mesh count and the stencil thickness.



The ink laydown is determined by the 3-dimensional structure of the mesh, namely the mesh thickness and the mesh opening. These parameters determine the amount of ink the mesh can hold and hence transfer to the substrate.

Increasing the total stencil thickness by applying a thicker emulsion coating will increase the amount of ink that will transfer to the substrate. However, this is only possible at line widths greater than 500 microns, where the stencil supports the fabric off the substrate. At line widths over 500 microns the stencil thickness influences only the edges of the lines and can create unwanted effects of dark shadows at the edge of a printed image.

When printing fine detail, the thickness adjustment of the stencil enables higher ink laydown with fine mesh counts.

General Coating Techniques

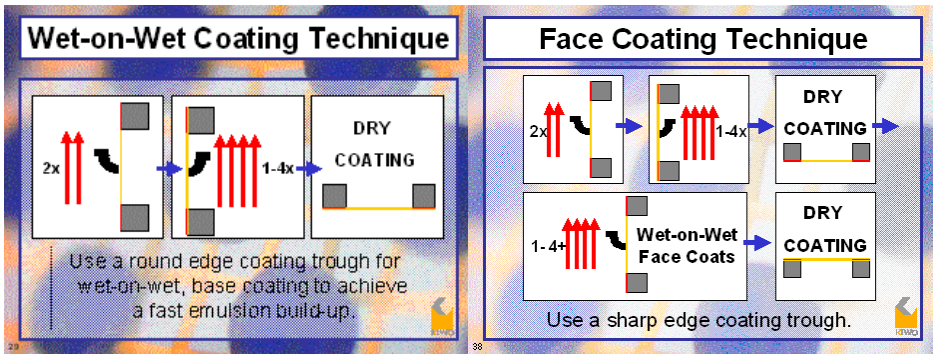
There are two coating techniques that give different results:

- Wet-on-wet coating for thick build up
- Face coating for thin build up

Wet-on-wet coatings produce excellent screens, but require an emulsion build up above the mesh of usually 20 to 25 percent of the mesh thickness. For printing adhesives, opaque inks and coarser images, this coating technique is fast and reproducible within a tolerance of plus or minus 2 microns. An automatic coating machine can improve the repeatability to a tolerance of plus or minus 1 micron.

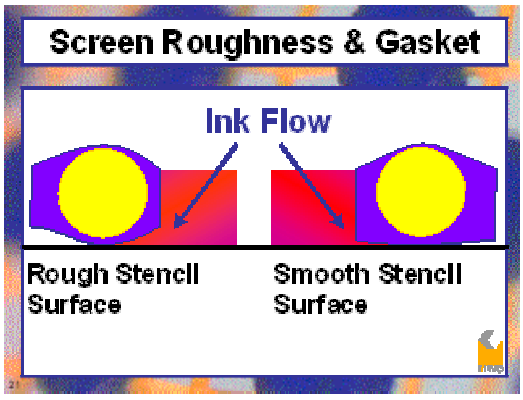
To maintain easy printing, the total stencil thickness should not exceed 50 percent of the finest line width. Screens for translucent or transparent inks where changes in ink laydown result in changes in ink density should be coated differently to achieve smooth coating at low emulsion build up.

The face coating procedure is a combination of a thin wet-on-wet base coating followed by wet-on-wet face coats on the print side of the screen. The face coats must be coated with a sharp edged coater, whereas for the base coats, a round edge coater can be used. Some coating troughs provide both edges in one tool. With this coating technique the thickness of the emulsion build up can be controlled within plus or minus 1 micron or better. It enables thin coatings with smooth surface and excellent repeatability even when coating manually. A minimum thickness of 5 microns above the mesh is necessary to print sharp lines.



Substrate and Stencil Roughness – A Tool to Control Image Sharpness and Static During Print

To achieve sharp images in printing it is essential to obtain contact between the substrate and the stencil. Good contact will act as a gasket seal between stencil and substrate and prevent the ink from flowing underneath the edge of the stencil. Poor contact results in ragged edges and sawtooth.



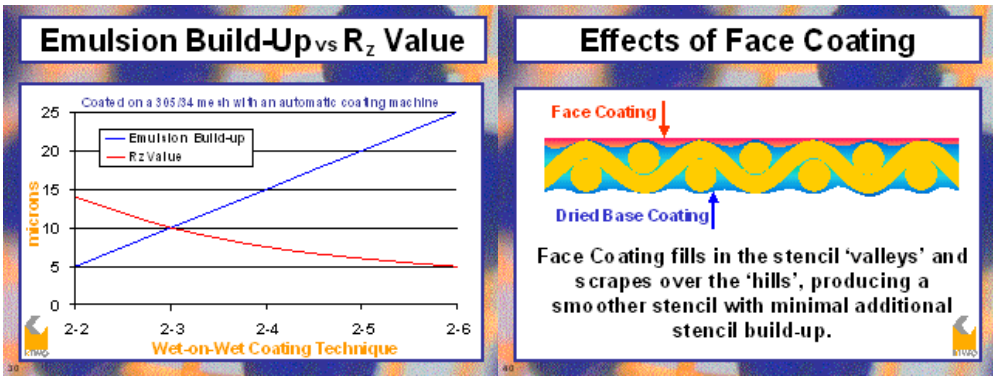
Perfect contact is achieved when both stencil and substrate are perfectly smooth. Poor contact is the result of rough substrate surfaces and rough stencil surfaces.

Although perfect contact may seem desirable for maximum image quality, it creates major problems on polycarbonate substrates. When printing on smooth substrates with very smooth screens, static electricity will build up. This will lead to problems during printing that can affect the print result and disturb the material flow in automatic printing machines.

To eliminate or reduce the static charges of polycarbonate substrates, a certain roughness is necessary. Tests have shown that most inks will produce sharp images if the total roughness between substrate and stencil is below 13 micron Rz (Rz is the average maximum height difference in micron on a given surface). As the substrate is usually predetermined and cannot be changed, the stencil roughness should be adjusted to match the substrate roughness.

For glossy polycarbonate with a surface roughness of below 2 micron Rz, a stencil roughness of 9 – 11 microns is sufficient. For textured or matte substrates with a roughness of 3 – 7 micron Rz, the stencil needs to be smoother, i.e. 6 – 10 micron Rz.

When coating wet-on-wet, thicker emulsion build up will result in smoother stencils. In some cases, however, the stencil may be too thick at a given roughness. When low emulsion build up is required, wet-on-dry coatings will improve the smoothness of the stencil without building up too much emulsion. The face coats will reduce the stencil roughness and increase the stencil thickness by only 1 – 2 microns.



With this coating technique the stencil thickness can be adjusted micron by micron and a repeatability of plus or minus 1 micron can be achieved even when hand coating.

Tools to Control Stencil Quality

Only a few measuring devices are required to control the stencil quality. For measuring the stencil thickness a nondestructive coating thickness tester can be used. The surface quality of the stencil and the substrate can be measured with a small nondestructive profilometer. To monitor the copying qualities of a stencil a 50x power microscope is sufficient.

Summary

For maximum print quality and control on the process of stencil making, liquid Diazo-photopolymer emulsions are the best choice. The chemistry provides excellent copying qualities and resistance for all inks and printing pastes.

Direct emulsion also offers the best adjustability in emulsion build up and stencil roughness. Both are important for the total print quality and trouble free production during printing.

When applying the stencil manually, capillary films have a repeatability that is comparable with wet-on-wet hand coating. Direct emulsions, however, give the option of altering the coating technique and thus achieve better repeatability.

The best option is the use of automatic coating machines that can apply both wet-on-wet and face coating techniques within very close tolerances and are not affected by changes in personnel.