Screen making for fine detail and 4-color process printing on garments

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Advancements in inks, mesh and stencil material have changed the area of garment printing and brought it to a new level. Textile printing has no longer the aura of a ma-and-pa shop, but is conceived of as high end printing. Challenges such as 4-color process on garments and printing on darks have changed the way we look at garment printing. There is one area that is still limping behind, however. The stencil making.

The screen room of the typical garment printer has not changed much in the last years. Advancements such as new mesh types and new stencil materials require a serious rethinking of the old habits and may lead to improvements in print quality as dramatic as higher screen tension did. This article will consider the stencil as a whole system and touch on mesh and screen room equipment as well as the actual stencil material and its application.

The Stencil Material

Most garment printers are using direct emulsion stencils. Low material costs and ease of use are the main considerations for this choice. Mainly 3 emulsion systems are common:

- **Diazo Emulsions**
- **SBQ-emulsions (pre-sensitized)**
- **Diazo-Photopolymer emulsions (dual-cures)**

Diazo Emulsions

Still widely in use, this system is the oldest type of emulsion on the market. Its main advantage is a very competitive price and average copying quality. For general printing jobs these systems are sufficient and provide a good cost/value ratio. Its limitations are typically in the areas of water resistance, resolution and viscosity/solids content ratios. The water resistance of Diazo-emulsions is very limited and usually requires the use of additional hardeners to withstand longer print runs. Some printers are actually using hot solvents such as lacquer thinner to "lock" the emulsion into the screen. Very often a high solids content automatically increases the viscosity and some Diazo-emulsions may not be suitable for coating fine mesh counts. Other than those shortcomings, however, these emulsions are specifically designed for garment printing and offer good all-round performance with plastisol inks.

SBQ-Photopolymer Emulsions

This system, although over ten years old, is just now gaining in popularity, as more manufacturers have access to the raw materials. The main feature of SBQ emulsions and similar systems is the extremely fast exposure speed that allows short exposure times with weak exposure lamps. These systems are pre-sensitized and have a long potlife. For users with a screen throughput of 400 and more screens per day, this type of emulsions is an excellent alternative to the other two systems. The shortcomings are short exposure latitude, usually mediocre resistance to water-based inks, high costs and average copying qualities, that don't rival standard Diazo-emulsions. There is the choice of high quality SBQ-emulsions, but only at premium prices above $ 90.-- per gallon. For shops with high usage the cost should be a main factor and the alternative could be a Diazo-Photopolymer emulsion at lower cost and the investment in several high power exposure units.

Diazo-Photopolymer Emulsions

The so called "dual-cure" emulsions are the newest emulsion system and offer the widest variety of quality levels. Everything from average overall performance to state-of-the-art copying qualities is available. All levels of resistances to printing inks are available to accommodate the specific needs for each shop. State-of-art Diazo-Photopolymer emulsions offer the best copying qualities, combine with excellent resistance to water-based inks, plastisols and even discharge inks. The are equally suitable for manual presses, automatic presses and belt printers. Another main advantage is wide exposure latitude at relatively fast exposure speeds.

Requirements for fine detail

When shopping for an emulsion, suitable for printing fine detail and 4-color-process printing, keep in mind that the task of printing is the "reproduction of the artwork correct in shape and size."

To allow true reproduction of the artwork the stencil material must comply with following requirements.

- **high resolution**
- **excellent mesh bridging**
- **wide exposure latitude**

Resolution is probably the most complex topic, as it incorporates the chemistry of the emulsion, the coating techniques, the mesh, the exposure unit and the ink. If the emulsion is not capable of reproducing the artwork on the screen, there is little chance that the print will be true in size and shape. Garment printing is especially challenging because the ink system requires coarse mesh counts to achieve good ink densities and longevity of the printed garment.

Resolution level 1:

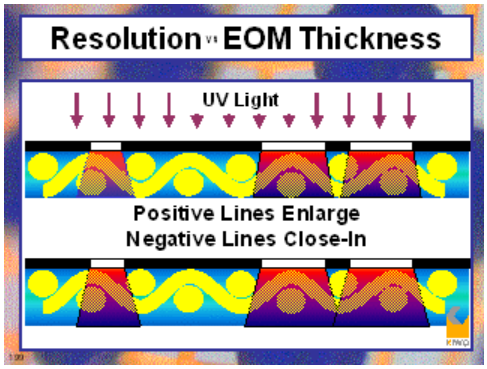
The chemistry of the emulsion enables a certain resolution. The main factors here are the sensitizer system, color of the emulsion, resistances to water and solvents and particle size of the emulsion. Level 1 describes the resolution limited by the physical and chemical properties of the direct emulsion. Diazo-Photopolymer emulsions offer generally the best resistances to water and prevent a swelling of the emulsion during the developing of the screen. Swelling of the emulsion will lead to loss of detail. The color of the emulsion is important as it filters any stray light or light

scatter caused by the raw materials of the emulsion itself and by the exposure equipment. A darker color will usually have higher resolution. The particle size may be limiting the resolutions if the particles are too large. Emulsions with highest resolution have particle sizes of 1-2 microns.

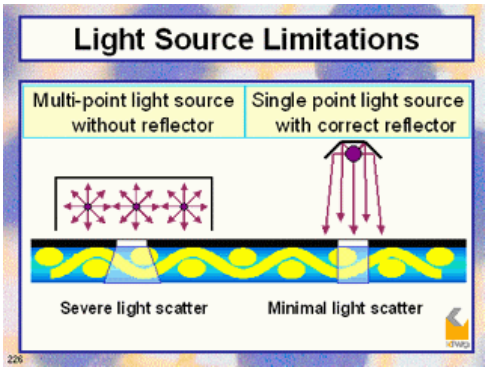
Resolution level 2:

Level 2 describes the resolution on the coated screen and is the step where the screen maker has most influence on the stencil quality. It incorporates the geometry of the mesh, the mesh color, the stencil thickness, the quality of the exposure unit, the exposure time and everything mentioned under level 1.

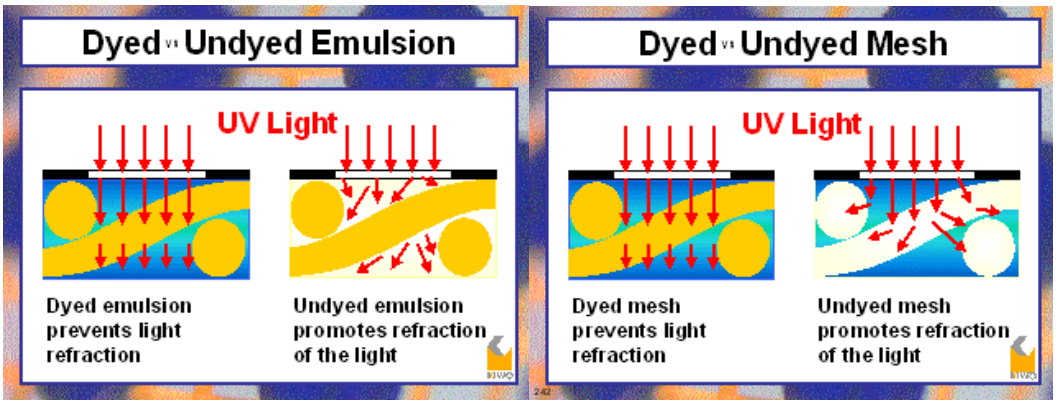
The geometry of the stencil (mesh and emulsion) is probably the most important factor in stencil making. The resolution of an emulsion on the mesh is influenced by the mesh thickness as well as thread mass (diameter). Light scatters produced by the exposure lamp and reflections within the emulsion and the mesh increase with a higher stencil depth, thus reducing the resolution.



In many cases the exposure unit itself is limiting the maximum resolution due to poor lamp and reflector designs. The exposure unit should provide collimated light output.



For optimum resolution use the thinnest possible mesh, dyed with yellow or orange color, coated with a dyed emulsion to the minimum emulsion build up of approximately 5 micron above mesh.



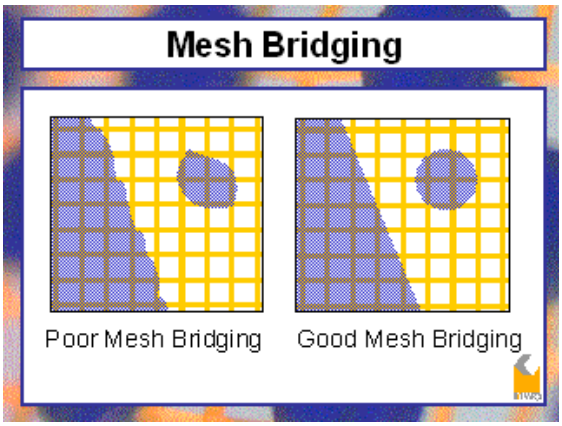
Garment printers typically use mesh counts such as 86T, 110T, 156T, 230T, 305T. Instead of using standard T-mesh, mesh counts with thinner threads can produce the same ink density, but improve resolution and ink transfer. Using a 355-31 mesh instead of a 230T mesh, for example, increases the resolution and detail dramatically without loosing ink density. The improved ink transfer with the thinner mesh and the large open area allows the ink to flow freely through the mesh and minimizes light scatter.

Resolution level 3:

Resolution level 3 includes both level 1 and 2 as well as the ink and its behavior during printing, the coating techniques and the physical properties of the stencil, such as emulsion build up and surface roughness of the coated screen.

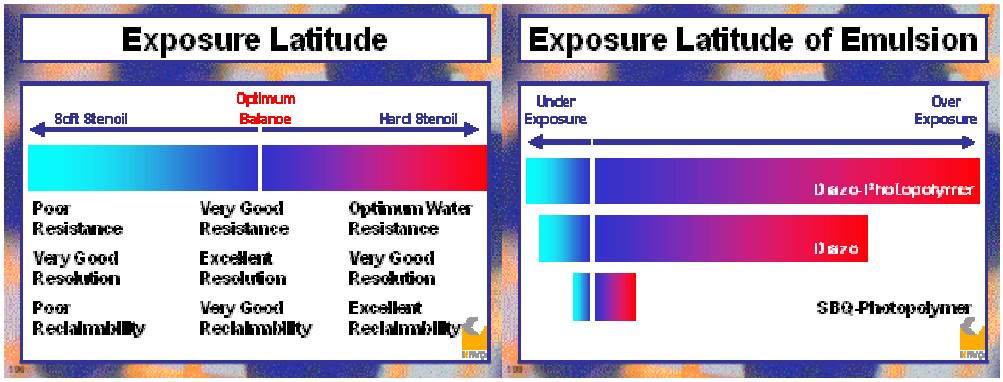
Mesh bridging:

Optimum mesh bridging is essential to reproduce the original artwork true in shape and size. Stencil materials with optimum mesh bridging will hold the shape of a copied image regardless of the mesh. Poor meshbridging causes the emulsion to "cling" to the threads producing severe "stair-stepping" rather than breaking away from the threads in whatever shape the artwork demands . Poor mesh bridging can change the shape of halftone dots, producing dot gain or dot loss.



Exposure Latitude:

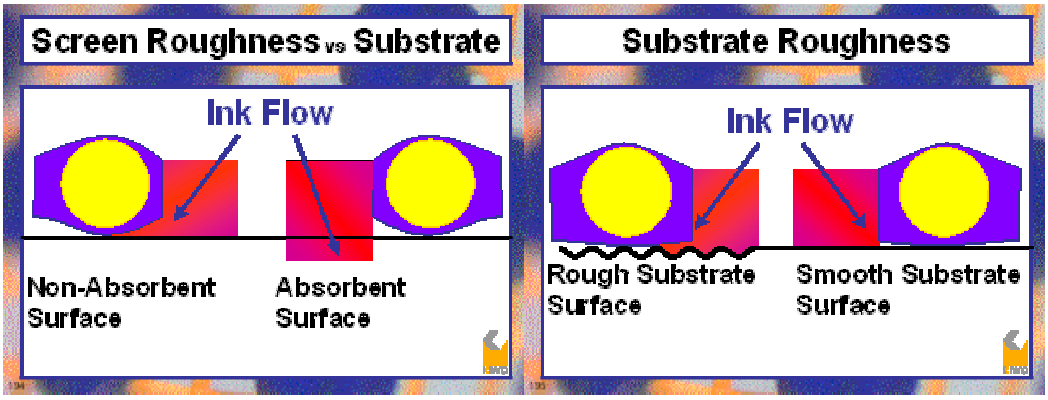
A wide exposure latitude proves to be extremely helpful when imaging very fine detail on coarse mesh counts. The emulsion absorbs the light scatter within the stencil and provides better resolution. A wide exposure latitude also compensates for variances in coating thickness and provides a safety blanket in production. The chances to lose a screen due to over- or underexposure are minimal, if the exposure time is set to the center of the latitude. For 4-color process screens, a wide latitude assures reproducible tonal values with repeat orders. It is essential when printing with water-based inks to allow complete crosslinking of the emulsion without loosing detail or highlights. A wide exposure latitude can in most cases eliminate the need to underexpose to hold fine detail especially when using older type exposure units or multi-point light sources.



Coating procedures:

Coating screens for fine detail and 4-color process printing on garments requires a little more thought than coating screens for simple 1 or 2 color designs. Factors such as flash curing in-between colors, the quality of the garment, underlying colors in 4-color process, stencil roughness and stencil thickness, require much more attention when printing fine detail.

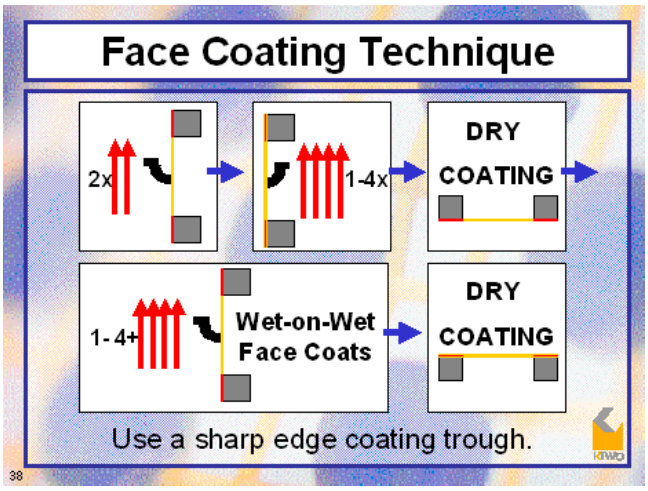
The print quality on garment varies with the quality of the fabric. Absorbent material with a smooth weave will produce better print quality than non absorbent material or coarse fabrics. Why does absorbent substrates produce better prints? The answer is simply that the substrate absorbs the ink and does not allow the ink to smear underneath the edge of the stencil. That is the main reason why garment printing is so forgiving.



This changes, however, when the substrate is changed from being absorbent to non-absorbent. That is happening during flash curing. The underlying colors close the fabric of the garment, making it non-absorbent. As of that moment, the garment behaves more like a plastic substrate and a different stencil profile is required to maintain a sharp print. The roughness of the stencil becomes important and the roughness of the garment also influences the print result. The rougher both surfaces are the poorer is the seal between substrate and stencil.

When printing with such a configuration, the ink is very likely to flow underneath the edge of the stencil and produce sawtoothing or unsharp image quality. In 4-color process printing it results in uncontrollable dot gain. To produce the best print quality a smooth garment should be used as substrate and the coating technique has to be changed to achieve a smooth stencil surface.

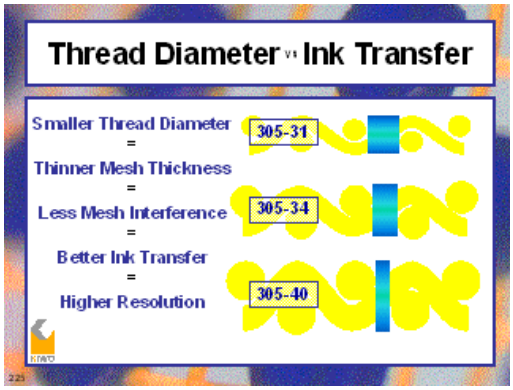
There are two methods to achieve a smooth stencil profile. Coating wet-on-wet with several coats on the squeegee side of the screen produces a smooth stencil at a certain stencil thickness. This coating technique may be suitable for most jobs, but the stencil thickness may be too high for fine detail and impair the ink release. Inferior resolution may be the result of this coating technique. When using mesh with thinner threads, however, a wet-on-wet coating can produce a smooth stencil roughness at a low stencil thickness.



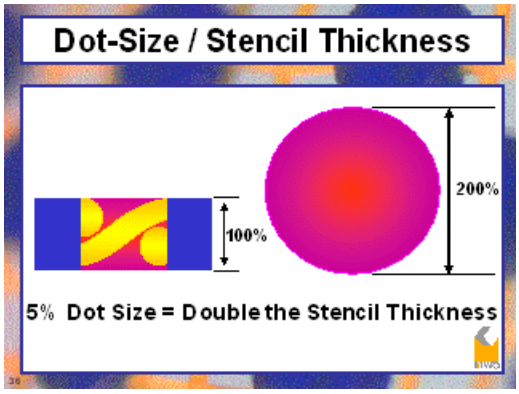
The second method of coating is face coatings or wet-on-dry coatings. Starting with a 1+1 wet-on-wet coat the mesh is filled with emulsion. After drying the screen several coats are applied to the substrate side of the screen with intermediate drying. This produces a thin, but very smooth coating and keeps the stencil thickness to a minimum.

Standard Rules

Printing fine detail or 4-color process can be relatively easy if the following rules can be applied. The main problem in printing fine detail is to transfer the ink through the screen onto the substrate. To allow the ink to easily release out of the stencil it is important to provide more surface area on the substrate versus the area in the stencil. Minimizing the thread mass in the image, i.e. using thinner threads and reducing the total stencil thickness improves ink release and resolution.



If possible, the finest line or the smallest dot should be as large as 2 mesh openings and 2 thread diameters combined or have a width twice the size of the total stencil thickness.



When following these rules it could be necessary to use finer mesh than usually and to coat the screens in a different way, but the gain is easier printing and higher print quality. These rules can also be used to establish guide lines for the art department. Just by using the data of the mesh and the 2 mesh opening plus 2 thread diameter rule, a maximum resolution for each mesh count can be set. If the art department follows the guidelines for the maximum resolution they can determine line widths or dot size for the mesh counts in use.

Conclusion

Understanding the limitations of the screen printing process, the stencil materials and the equipment used to produce a stencil is essential to successful printing of fine detail or 4-color process. To achieve highest resolution and easiest ink release everything needs to fall in line. The mesh should have a thin thread and a low thickness to minimize surface area and light scatter and aid in ink release. The emulsion must have a small particle size and wide exposure latitude to provide a smooth edge and enables complete hardening of the stencil without loosing detail. The exposure unit should have collimated light output to eliminate the need to underexpose when fine detail is required. The screen must have a smooth surface to provide a good seal between substrate and stencil. And finally the screen must have a low emulsion build up and the finest detail should be no larger than 2 mesh openings plus 2 thread diameters. The reward for fulfilling all those requirements is troublefree printing of finest detail on garments.