

Screen Printing UV Special Effects Thick Deposit Graphics and Textures



Special effects printing, such as overprint clears, metallic effects, functional inks and security inks has grown significantly in the last few years. Most specialty applications used by UV graphic printers such as mesh, stencil and printing techniques can be used without much consideration to the overall process. However, when printing thick deposit effects to simulate textures or add 3-D structure to the print surface, the process can vary from creation of the artwork to pre-press to printing and finishing.

This article provides a processing guide for addressing these considerations upfront. Doing your homework can make a big difference in effectively overcoming the obstacles to successfully (and profitably) printing these effects. Consider the recommendations as general guidelines to help you define where to start and to lead you to establish shop parameters specific to your location and each application.

While there are many thick printing inks and effects, I will start with UV heavy build-up clears. This type of product typically is used to overprint graphics or directly onto the substrate to provide a glossy, water-clear 3-D effect.

Applications may include:

- Braille printing
- Simulated smooth, glossy textures such as tile surfaces, eyeglass lenses,

The typical goal in printing the heavy build-up clear is to provide a thick deposit of ink with a smooth, even and glossy surface.

- water drops, ice cubes, goose bumps and glossy clothing surfaces
- Limited simulated doming effect
- Simulated raised embossing

Considerations when Making Stencils

Mesh

The ink's deposit is significantly dependent on the mesh chosen. Using a fine mesh stencil, a heavy build-up clear or a standard UV overprint clear produces essentially the same result. The benefits to using a UV heavy build-up clear are typically seen when the mesh count is 156 tpi/60 tpcm or lower with a thick stencil build-up. Also consider using a larger mesh opening to more easily transfer ink and reduce potential mesh marks which result in a smoother printed ink surface.

Stencil Build-Up

If the stencil build-up is too low, the mesh interferes with smooth printing results and leaves mesh marks on the surface of the ink or by causing voids in the print area. The ink itself can be thinned to provide a smoother print surface, but the resulting decreased height of the printed

ink is counter to a thick deposit. It is recommended to make at least a 75–150 micron stencil build-up.

Depending on the print conditions, a stencil build-up of more than 150 microns can leave too much ink deposit, resulting in under-curing or too great a height of ink which causes significant issues with transfer when printing. If the deposit thickness is not achieved with a single print pass, multiple print passes can be used. A higher stencil build-up also provides a stencil gasket to the substrate and produces a clean printed edge on the detail. Otherwise, the printed image may appear jagged.

Figure 1 is a side view of a stencil with extreme stencil build-up. The top of the image shows the stencil surface to be very smooth. When the stencil comes into contact with the substrate, the ink flows to the stencil edge but not beyond, producing a clean printed edge.

Stencil Build and Artwork Size

A key factor to consider with stencil build-up is its relationship to the



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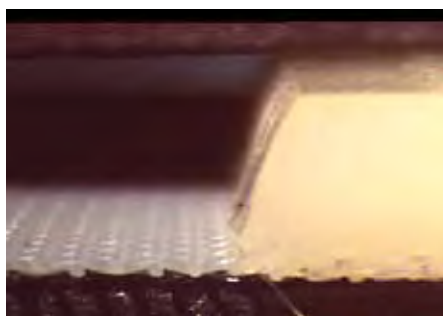


Figure 1: Side view of a stencil. Photo courtesy of KIWO.



Figure 2: A grid view of a printed image cut through the substrate and ink film.

artwork's detail size. With smaller detail, the stencil walls hold the mesh off of the substrate while printing, resulting in an even deposit of ink across the printed surface. When the span of detail from one side of the stencil's edge to the other becomes too great, the mesh can deflect under squeegee pressure and touch the substrate. The resulting printed image exhibits a higher deposit of ink along the edge of the artwork and a lower deposit of ink in the center of the artwork.

Figure 2 is an angled view of a printed image cut through the substrate and ink film. The left curved line is small enough in width for the ink surface to round up. As this detail becomes large in width, the surface begins to flatten out. The comma shaped artwork on the right shows a rim around the edges and a dip in the middle.

The artwork and stencil size ratio is a significant consideration when exposing a stencil; there is always some degree of under-cutting of the light resulting in an angle along the stencil's edge. Thicker stencils exaggerate this under-cutting and result in a change in size from the artwork to the stencil.

Figure 3 is a close-up view of a thick stencil using a clear emulsion, photo-film and an 8k metal-halide lamp. The image shows clearly that the printed size



Figure 3: Thick stencil using clear emulsion, photo-film and an 8k metal-halide lamp. Photo courtesy of KIWO.

of "rio" will be reduced. See how the detail in the dot in the "i" is more affected than that of the "o."

To achieve the desired printed effect, the balance of the artwork, stencil thickness and stencil exposure have to be qualified prior to moving onto full scale production. When starting to use a heavy build-up clear, it is best to establish the stencil build-up and run test images to determine the largest and smallest artwork size that prints cleanly and smoothly across the surface of the detail.

Stencil System

Because a coarse mesh count and high stencil build-up is needed, special considerations must be made with regard to the stencil system. You can use either a capillary film or emulsion. With both types, a pure photopolymer or SBQ stencil system is ideal because these products provide the fast exposure needed for effective stencil processing. A diazo or diazo-photopolymer/dual-cure product can be used, but the exposure times can be so long that the screen department may go crazy and the exposure systems might rebel.

UV ink does not attack a stencil system like a water-based or solvent-based ink does, so a textile grade capillary film or emulsion can be an appropriate choice. However, the solvent used at press or in reclaiming can potentially "lock-in" the stencil. During reclaiming, the stencil may come off in chunks or sheets. The screen department may need to take special actions to filter out "lock-in" or non-dissolved stencil material. If this is an issue, consider moving to a solvent-resistant SBQ/pure photopolymer product. The other option to reclaiming a "locked-in" stencil is simply to cut the mesh out and re-stretch the screen.

Choosing a stencil system comes down to a choice between time and money. Capillary film provides fast processing at a higher cost; direct emulsion is less expensive and is more time consuming.

The quickest means to providing a high stencil-build is to use a thick capillary film. Typically, a capillary film sinks into the mesh about one-quarter to one-third of its thickness, so choose the capillary film product appropriately. Also consider applying direct emulsion on the squeegee side of the screen to help secure the capillary film to the mesh. Capillary films also have the added advantage of being applied and dried quickly. If speed is required in the process of making a screen, capillary film is the way to go.

Because most graphic printers are familiar with direct emulsion, it is easier to establish stencil making procedures that

Summary of Recommendations:

- 156 tpi/60 tpcm or lower
- 75 to 150 micron stencil build-up
- Solvent resistant, pure photopolymer or SBQ capillary film or direct emulsion
- Full drying of unexposed stencils
- Use high pressure to develop the stencil
- Post expose screens when appropriate
- Conduct step-exposure testing and use the screen to print and evaluate artwork resolution
- 60 durometer squeegee
- Slower flood bar speed
- Higher off contact
- Use non-porous substrates
- Print several layers to gain extreme thickness

are not significantly different from current stencil processing. Start with an emulsion with high solids content, but note that there are new products on the market that provide extremely high solid content that are ideal for this application. Higher solids content results in thicker emulsion coating with less dripping and faster drying.

Begin by coating the substrate side of the screen using the round edge of the coater. Coat as many times as it takes to produce a glossy, smooth coating on the squeegee side of the screen. Then coat two to five times on the squeegee side of the screen. More coats may be applied, provided the emulsion does not drip or sag on the mesh while drying. Figure 4 shows a screen being coated from the squeegee side of the screen.

It is critical to dry the screen as much as possible after this initial coat to drive as much water out of the coating as possible; water retained in the stencil will affect exposure and may result in severe under exposure. This is true for emulsions and capillary films.

Once dry, coat the screen using the round edge of the coater on the substrate side of the screen with multiple wet-on-wet face coats. Apply light, even pressure when coating wet-on-wet to help deposit as much emulsion to the surface as possible without causing dripping. Dry the screen and repeat as many times as it takes to achieve the stencil build-up required. Again, be sure to dry the screen completely.

Step-test coating of the initial coating and the face coating should be conducted to determine the procedure that works for each application.

Exposure and Artwork Film

Before going into full production, conduct an exposure test spanning small to large artwork detail. Because of the thick stencil build-up, there will likely be under-cutting of the artwork that results in significant closing in of detail. Exposure times and levels should be balanced between achieving full exposure to provide the highest level of physical and chemical stencil strength and keeping detail open. This also allows for more water pressure to be used in developing the screen. In most cases, exposure should be as close to full exposure as possible to help overcome deficiencies in drying the stencil before exposure.

Once the exposure test screen is made with the varying detail, it is used to conduct test printing. The resulting size of the printed artwork can be directly compared to the film's artwork to alert the art department of the size needed to build into future files to print the desired finished size.

Be aware that thicker stencil build-up inherently results in a very smooth stencil

surface. When exposing, this smooth surface can stick to the film and glass. Extra care may be needed to separate the stencil from the glass. If so, go slowly in separating the two and be sure to clean the glass if any residues are left. In my internal testing, the artwork film is created using an aqueous (water-based) digital printer, so any water residue in the stencil will soften the ink on the artwork and stick to the stencil surface. In this case, I expected the film to be used only once.

Developing

Developing the screen requires water to soften and dissolve the unexposed areas of the stencil. With its extreme thickness, the water takes a long time to penetrate through the stencil when compared to other graphic applications. If the screen is small enough, a dip tank can greatly speed up the developing process by submerging the screen in water for several minutes and spraying out the stencil with a power washer.

Otherwise, spray down the stencil on both sides of the screen and allow the water to soak into the stencil. Continue to spray the stencil off and on with low pressure and intermittent high pressure. This process may take several applications. Once the stencil starts to open up, continue to use the high pressure sprayer, focusing more attention on the substrate side of the screen. The stencil should be able to handle a high pressure sprayer from 10–12 inches away from the screen without blowing away from the mesh. If the stencil degrades under pressure, then it was underexposed.

Take care not to under-develop the screen. Any residue along the artwork's edge or on the mesh threads may be seen in the printed image and result in jagged edges or mesh marks in the image. Thoroughly dry the screen.

Post-Exposure

Post-exposing the screen can help to improve the durability of the screen and is recommended in some situations. Pure photopolymers/SBQ stencils can be post-exposed using three or more times the original exposure time to gain additional reaction in the stencil. The post exposure helps to cross-link any under-exposed parts of the stencil, increasing the physical and chemical strength of the stencil. When printing a clear ink, any under-exposed stencil may mix in with the ink and tint the clear. Post-exposure helps to limit any unwanted stencil breakdown during printing.

Printing Considerations

Squeegee Durometer

The typical goal in printing the heavy build-up clear is to provide a thick deposit

To achieve a more dramatic effect, heavy build-up clears can be layered. Layering is especially useful when an extremely thick deposit of ink cannot be cured or if finer detail cannot be achieved on a coarse mesh.



Figure 4: A screen coated from the square side of the screen.

of ink with a smooth, even and glossy surface. A big influence is the squeegee durometer — a softer squeegee tends to deposit a heavier and glossier print. I recommend starting with a 60-durometer squeegee. A harder or softer squeegee may be used as a back-up to tweak the result, depending on the desired effect.

Squeegee Pressure and Angle

Too little squeegee pressure results in the ink not transferring to the substrate. Too much pressure smashes the stencil and can cause smearing along the edges of the artwork. The squeegee angle also can be manipulated to adjust the ink deposit to result in a lower angle that deposits more ink. Once the squeegee pressure and angle are dialed in, this printing variable minimally impacts the ink deposit. Figure 5 is a side view of the squeegee with a lower angle setting.



Figure 5: Squeegee with a lower angle setting.

Squeegee pressure and angle must be considered when setting up the press and experimenting to achieve the desired result, but when attempting to overcome big issues, changing these settings has minimal influence.

Flood Bar Pressure

To fill up the open areas of the stencil, the flood bar needs to move a lot of thick ink across the screen. Decrease the flood bar pressure to leave more ink on the screen's surface. Reduced flood bar pressure results in more ink in the image area and a smoother printed surface.

Flood Bar Speed

To further fill up the open areas with ink, set low pressure on the flood with a slower flood bar speed to better saturate the open areas. Figure 6 shows a printing press set with a slow flood bar speed and fast squeegee speed.



Figure 6: Printing press set with a slow flood bar speed and a fast squeegee speed.

Squeegee Speed

With the open areas filled with ink, slowing down the squeegee speed leads to ink smearing along the print edges. So you don't upend a clean print result after making a stencil with a good gasket, opt for a faster squeegee speed. If significant air bubbles form in the ink, slow it down. Play with this setting to gain the best balance for the required printed effect.

Off-Contact

Because a coarser mesh is used and the detail is larger than normal graphic applications, a higher off-contact is necessary to increase snap-off of the screen from the substrate. In most cases, this helps to provide a better transfer. Off-contact

should be set up based on the specific print conditions and artwork, but should not be in too close a proximity to the substrate. If it is, the printed surface may exhibit an orange-peel appearance.

Ink Level and Usage

Compared to normal graphic applications, printing a heavy build-up clear through a coarse mesh with a thick stencil is going to use up a lot of ink very quickly. I recommend having more ink in the screen and adding more ink than usual to keep printing continuously and smoothly. A typical UV halftone ink in a fine mesh will yield 3,200–4,800 square feet per gallon versus 500–1,100 square feet with thicker deposit inks.

Substrate

I do not recommend using heavy build-up inks with porous substrates because the ink will dive into the substrate's surface and inhibit full cure. If these substrates are required, pre-print them with a faster curing UV ink to produce a non-porous surface where the heavy build-up clear will be printed. Any inter-printing of inks should be tested for compatibility prior to full-scale production printing. In addition, the smoothness of the substrate affects the resulting flow-out of the ink along the edges of the artwork and on the ink's surface. A smooth substrate produces a smoother print result.

Due to the thickness of the ink deposit, a thin gauge substrate does not provide enough support to the ink — a thicker substrate is required for most applications. Not only will a thicker substrate support the finished print better, if the substrate shrinks or expands during printing or as a reaction to the ink, a thicker substrate will handle these changes better and result in a flatter printed piece.

Checking for Cure

UV inks cure from the surface of the print down. As the top layers are cured, UV light has to travel through the cured layers to reach the layers at the surface of the substrate effectively. While the surface of the ink may feel cured, the bottom layers may not be. It is best to check adhesion with an aggressive thumb twist, tape application and cross-hatch plus scratch test. If one layer produces the desired results, printing multiple layers at the same settings should also produce acceptable results. Figure 7 shows a UV curing unit that is well maintained to provide optimum performance.

Because it is difficult to cure a thick ink deposit, I do not recommend tinting heavy build-up inks. The added pigment of the ink blocks the UV light from effectively curing the ink. Adding five percent of a colored ink can result in total cure failure. To gain color in these areas, graphics should be printed first and heavy build-up clear should be printed last. Depending on color, ink deposit, substrate and UV output, you may be able to get away with slight tinting, but the responsibility for qualifying and testing the finished print is on the printer's shoulders and requires good curing equipment in excellent condition.

Some special effect powders or pastes in heavy build-up inks may be used provided that the particle is somewhat transparent, such as with a pearlescent powder. In this case, less than three percent should be used. The addition of any powder or paste can lead to curing issues and should be qualified prior to full-scale production.

Post Cure and Flexibility of the Ink

For a UV ink to cure with a thick deposit and provide a hard surface, the ink is inherently rigid. One layer of ink typically retains enough flexibility to allow for cutting and other finishing processes, but with several layers of ink on top of each other, it can fracture, crack or pop off the substrate. Be cautious of cutting through or near the printed ink film; issues related to cracking or fracturing should be discovered prior to full-scale production. Inks may continue to post cure for 24–48 hours and increase in rigidity. Qualifying the finishing of the prints should take into account the flexibility and post curing of the ink.

Stacking

Because of the ink's surface hardness, print stacking should not be an issue, though there are some considerations. Excessive heat could soften the ink's surface and allow potential blocking, most often seen with heat over long periods of time and excessive weight. Be sure that stacks of prints are monitored when using this type of ink to determine when extreme environmental conditions impact blocking.

With multiple layers of ink, the difference in height from the substrate to the ink could be considerable. If prints are stacked and the substrate is soft, as with coated paper, the weight of the stack would press the back side of one print into the surface of the other. The prints may stick together or emboss each other. Do not assume that if one substrate passes all the

stacking and finishing processing with the ink, the same will be true of any substrate.

Reclaiming

At press, the ink is relatively easy to clean out of the screen. I have two suggestions to help reclaim the screen: 1) Clean the screen as much as possible and use a hand held squeegee to push residual ink and solvent through the mesh to help clean out the ink along the stencil edges, and 2) Clean as much excess ink out and apply a small bit of colored ink to the screen. When the color is cleaned completely, you know the clear ink is also completely cleaned.

With extremely thick stencils, clean all the ink off on press and in the wash out area. Soak the screen with water for a few minutes prior to applying the stencil remover. This initial water soaking helps open up the pores in the stencil and allows the reclaiming chemical to penetrate through the screen. Otherwise, the stencil will likely blow off the screen in chunks or peel off the surface. If the stencil does not dissolve, the screen area should have a way to catch the solid waste before it goes down the drain. Over time, this gummy residue could build up and clog drains.

Artwork Considerations

Layering Artwork

To achieve a more dramatic effect, heavy build-up clears can be layered. Layering is especially useful when an extremely thick deposit of ink cannot be cured or if finer detail cannot be achieved on a coarse mesh. Internal printing shows success up to 7–9 layers of ink. Beyond that, the printed ink can become pointed and damage the screen or squeegee. With any amount of layering, the total print first should be qualified from printing through finishing before going to full-scale production.

When using the same stencil and stacking ink upon itself, the ink only transfers to the areas with which it comes into contact. The result is that the image shrinks slightly in size with each printed layer. For example, printing a circle upon itself results in a cone shape when viewed from the side. The bottom of the print or first layer is much wider in dimension than top point with the last layer.

Figure 10 is a top-down view showing a square printed onto a white substrate. As indicated with the black arrow, the first layer is significantly larger than the seventh layer (seen in blue). This reduction in size helps provide a more rounded appearance to the print.

Remember that when the artwork is too large and ridges form around its edges, they

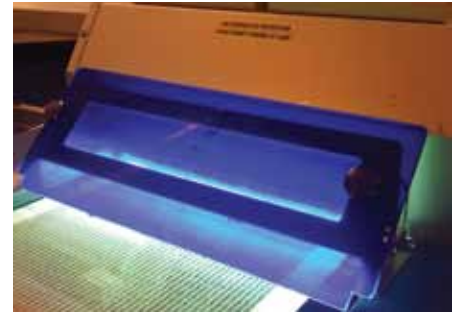


Figure 7: UV curing unit that is well maintained to provide optimum performance.



Figure 8: A screen in the stencil reclaiming process.



Figure 9: A view of the bottom of the reclaiming sink. The chunks of un-dissolved emulsion were filtered before going into the drain.



Figure 10: A top-down view showing a square printed into a white substrate.

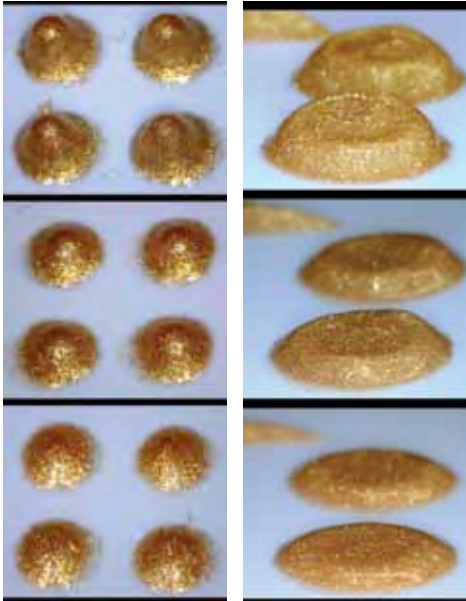


Figure 11: Smaller circles show how the layers of ink lead to a cone shape.

Figure 12: Larger circles result in an outer ridge line and a sunken middle that is exaggerated with more layers.

become exaggerated with additional layers of ink. Figures 11 and 12 are three, five and nine layers of a heavy deposit clear plus three percent gold pearlescent powder. The smaller circles in Figure 11 show how the layers of ink lead to a cone shape. Figure 12 is a slightly larger circle that results in an outer ridge line and a sunken middle that is exaggerated with more layers.

When layering ink, UV light will prematurely yellow any ink. To see a demonstration, print two sheets. Expose one print to UV light once and the other print to eight or more UV cure cycles. The color of the repeatedly-cured print will look more yellow. When printing multiple layers, expect a slight yellowing of the clear. The more layers you have, the more pronounced this effect will be.

Dialing in the Ink to Gain the Desired Effect

The key recommendation to printing this type of effect is to do your homework first. Many graphic printers have not previously considered a mesh count below 305 tpi/120

tpcm or a squeegee below 80 durometer. There are new considerations to take into account with this ink that are not standard procedure. By dialing the exposure time, the amount of time to process a screen, the print parameters and the possible print detail, printing this ink and being able to turn a profit in these jobs becomes a lot easier.

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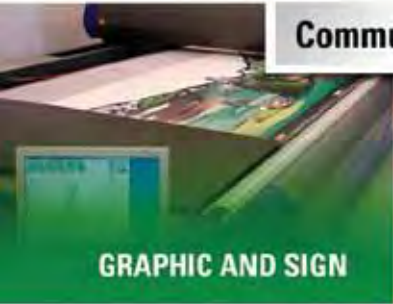
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