Overview

This bulletin provides graphic manufacturers with instructions on using 3M™ Screen Printing UV Ink Series 9800 inks in creating line color and four color screen printed graphics. Topics covered include preparing sheets for printing, thinning inks, mixing inks while maintaining color density in a tight range, and the full screen printing process. Testing methods to ensure inks are the desired color and that they have properly dried after application are also included.

Users should read and understand this bulletin before starting to create graphics. Reading the supporting product and instruction bulletins referenced in this bulletin, especially for any products they are using, will also help users create successful graphics.

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Product Line

Opaque Colors				Transparent Colors		Process Colors		Clears	
9802	Opaque Black	**9830**	Orange	**9825**	Blue Shade Red	**9805P**	Black	**9800CL**	Clear
9803	Mixing Black	**9837**	Red Shade Yellow	**9828**	Yellow Shade Red	**9815P**	Magenta	**Other Products**	
9806	Mixing White	**9843**	Medium Yellow	**9831**	Orange	**9845P**	Yellow	**9800B**	Halftone Base
9808	Opaque White	**9849**	Lemon Yellow	**9840**	Medium Yellow	**9875P**	Cyan	**9800HBB**	Heavy Body Halftone Base
9812	Magenta	**9861**	Light Green	**9848**	Yellow			**9801**	Thinner
9813	Red Violet	**9879**	Green Shade Blue	**9864**	Blue Shade Green			**9810**	Toner
9826	Brick Red	**9891**	Blue Violet	**9882**	Red Shade Blue				
9827	Red								

NOTE

Custom blended colors are available. Contact a 3M Commercial Branding and Transportation Division sales representative or customer service representative for more information.

Sheet Preparation

Sheet Conditioning

A change in humidity or temperature can affect the moisture content of the liner during storage and/or printing. These changes can affect the liner's size and lay-flat characteristics, as well as graphics with tight tolerances or multiple colors by affecting registration and page alignment.

Observe the following guidelines for the best results.

All Liners

- Use films with polyethylene-coated liners.
- Keep film sheets wrapped in polyethylene.
- Do NOT condition film sheets by running them through a UV cure unit.
- Complete the printing as quickly as possible.
- Avoid stacking sheets of film in an uncontrolled environment. The stacked sheets absorb moisture unevenly and may develop wavy edges.

Kraft Paper Liner Only

- Stabilize the sheets under the shop's normal humidity and temperature conditions.
- Condition the sheets overnight by racking them individually or by placing two sheets face-to-face.

Cutting

The sheet size and direction the sheet is cut from the roll can affect liner stability relative to humidity and temperature variations. For the best results, follow these guidelines:

- Print fewer graphics on a smaller sheet size instead of printing more graphics on a larger sheet.
- If possible, cut all sheets in the same direction and put the critical length parallel to the roll edge.

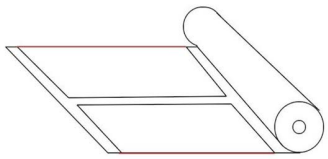

Figure 1. Critical Length (in red)

Scotchlite™ Reflective Graphic Film

Close color matching of multi-sheet graphics is difficult on retroreflective materials because production lots may vary. Adjoining panels of reflective graphic films must be checked for both daytime and nighttime appearance.

Follow the recommendations in 3M Instruction Bulletin Production: Graphic Design, Storage, and Handling to minimize within-lot and crossweb variation. 3M™ Scotchlite™ Reflective Graphic Film 680-10 and 680CR-10 are available already color matched.

Liner Printing

Liners That Cannot Be Printed

Most Scotchcal™, Scotchlite™, and Controltac™ brand films use polyethylene-coated paper liners, which cannot be printed on.

Liners That Can Be Printed

Kraft paper liners on some 3M films can be printed on. Print the liner before screen printing the graphic.

Methods For Printing Liners

The graphic manufacturer is responsible for testing and approving any printing on the liner. Follow the ink manufacturer's processing instructions.

- **Screen printing:** Use a fast drying screen printing ink for paper. Rack the sheets individually until they are dry—at least 30 minutes.
- **Printing on a press:** Use a fast-drying, black halftone ink. Stack the sheets.

> **NOTE**
> Ensure the ink used on the liner does not transfer to the film or to Ink Series 9800 inks later during processing. Slip sheeting may be necessary.

Ink Series 9800 Coverage and Preparation

Line Color: Typically, one U.S. gallon (3.8 liters) ink covers 2,500 to 3,500 sq ft (232 to 325 sq m).

Press Ready Ink: Typically, one U.S. gallon (3.8 liters) covers 8,000 sq ft (743 sq m) at 50 percent dot with a 390 tpi plain weave mesh.

Clear: Typically, one U.S. gallon (3.8 liters) covers 2,500 to 3,500 sq ft (232 to 325 sq m) with a 390 tpi plain weave mesh.

However, several factors affect the ink coverage, including:

- Screen mesh and type
- Hardness (durometer) and angle of the squeegee
- Angle of the squeegee
- Emulsion thickness
- Average halftone-dot density

Mixing

- Return any ink adhered to the lid to its container.
- Thoroughly mix the ink before formulating colors or printing. This ensures an even distribution of the ink components.
- Use a high-speed power mixer with a blade 1/3 to 1/2 as wide as the diameter of the container. If the blade is smaller than this, move it around in the container while mixing. Put the blade 2/3 of the way into the liquid while mixing.

Clear Preparation

Clear 9800CL is press ready. Do NOT dilute with a toner, thinner, or base as doing so will reduce clear durability and gloss.

Color Matching with Clear 9740i

When considering critical color matching of light colors, always consider that Clear 9740i has a yellow tint when cured in a focused-lamp cure unit. See 3M Product & Instruction Bulletin UV Clears for more information about the cured, clear color.

Ink Preparation for 4 Color Process

Color is supplied as a concentrate and must be thinned to achieve the desired density. If an existing formula for Ink Series 9800 is not known, use the suggested percentages in the following table. The results are based on 3M testing and equipment using a 390 tpi plain weave mesh. Press conditions will influence users' results.

1. Print a test sample.
2. Adjust density according to the "Color Control 4 Color Process" on page 5.
3. Adjust the viscosity:
   a. Replace all or part of Base 9800B with Toner 9810 or Thinner 9801 to decrease viscosity.
   b. Replace all or part of Base 9800B with Halftone Base 9800HBB to increase viscosity.

Typical Color Densities

Ink	100% Ink	75% Ink 25% HTB	62.5% Ink 75% HTB	50% Ink 50% HTB
Cyan	1.68	1.44	1.28	1.07
Magenta	1.74	1.57	1.42	1.25
Yellow	1.00	0.92	0.84	0.76

Tinting and Toning

- Use Ink 9806 Mixing White to tint colors.
  - Use less than 95% by weight of Ink 9806. Using more may affect the color's durability.
- Do NOT use Ink 9808 to tint colors. This opaque ink is a block-out color only.
- Only use Toner 9810 to tone colors.
- Do NOT tone or thin the clear.
- Use less than 50% by weight of any combination of Thinner 9801, Toner 9810, and Halftone Base 9800B. Using more may affect the durability of the color.

Reducing the Viscosity

- Thin the inks with less than 10% by weight of Thinner 9801.
- Test the formulation for printability.

Increasing the Viscosity

- Use Halftone Base 9800B to thicken the ink. This may be necessary for printing fine lines, copy, or halftone patterns.
- To increase the viscosity by 500 centipoise, add 1 to 5 percent by weight of Halftone Base 9800B to the ink.
- Do NOT add more than 50% by weight of Halftone Base 9800B to an ink formula.
- Test the formulation for printability.

Foaming

Foaming may occur when the print rate is greater than 1,000 impressions per hour. Foaming creates entrapped air bubbles that give a poor flow-out appearance. Add less than 10% by weight of Thinner 9801 to reduce foaming.

Using Ink Series 9800 Inks on Scotchlite™ Reflective Graphic Film

- Ink Series 9800 inks are compatible with reflective graphic films. However, not all Series 9800 inks are transparent. Using a formulation containing an opaque ink prevents the film from properly retroreflecting in the printed area.
- Print the ink formulation and view it under nighttime conditions to determine if the retroreflectivity is adequate.
- Users may need to add toner to maximize the nighttime retroreflectivity of full strength blends of transparent inks.

Screen Printing

Frame

- Use a rigid, metal frame.
- Include a 6 to 10 in. (15.2 to 25.4 cm) well between the frame and the graphic design on all sides.
- Use a screen tension of 20 newtons/cm or higher after applying the emulsion coat. Higher tensions produce a more uniform print while minimizing printing problems. The emulsion coating lowers the tension.
- Tension the fabric the same amount in both directions on a screen, and the same on all four screens. Uniform tension is absolutely critical for printing matched panels.

Fabric

- Use a polyester, monofilament, 355 to 390 tpi plain weave fabric.
- Use a thread with a diameter of 31 to 34 microns.
- The thickness of 9800CL Clear will be 10 to 15 microns depending on the fabric used.

NOTE

Calendared fabrics, twill weaves, and thick threads affect ink lay down and can cause printing and curing problems.

Stencil

Choose a stencil system that produces a thin, uniform coating with a very smooth surface on the print side of the screen.

Indirect Emulsion Capillary Films

Use a film that is 15 microns or thinner.

Direct Emulsion

- Consistent and uniform emulsion thickness between screens is critical for making matched panels.
- Use a high quality emulsion, either diazo, photopolymer, or a diazo-photopolymer combination.
- Multiple coats are necessary to obtain a smooth surface on the print side of the screen.
- The emulsion thickness should not exceed 5 microns. Thicker emulsion produces higher dots, causing printing problems. With a sharp scoop coater, apply two to three wet coats on the print side, and two coats on the well side of the screen. Experiment with various coating techniques to obtain the best results.
  - Devices measuring the thickness of a dried emulsion coating are available to help establish the proper stencil system.
- Expose the screen in a vacuum frame with an exposure lamp placed further away from the screen than the length of the screen's diagonal measurement. Monitor each exposure with a transparent gray scale. Compare the exposure to previous ones that produced good results.
- Maintain tight, uniform contact between the halftone positive and the stencil throughout the exposure. Poor contact in any area will make the screen unusable.
- Include a color bar if the positive does not have one. A 1 sq in. (6.45 sq cm) piece of opaque tape in the trim area of the positive creates an opening in the screen that prints a solid. Position color bars so that they do not overlap color bars for the other colors.

Squeegee

Multiple durometer squeegees (70/90, 65/95/65, 70/90/70, or 75/95/75) provide the best results. A sharp squeegee with an 80 durometer or harder plastic blade will also work. Using a softer squeegee increases ink lay down and can make printing more difficult.

The squeegee should be large enough to overlap the design by at least 2 in. (5 cm) on each side.

Set the squeegee angle as near to vertical as possible. The angle should NOT be less than 80 degrees. The exact angle may vary depending on the press design. Lower angles may result in heavier ink lay down, which may cause printing and curing problems.

Printing Method

1. Remove any dust or particles from the fabric, stencil, and film sheets by using a varnish-soaked cloth. Cleanliness and controlling dust are important for achieving good results.
2. Position the film on the press bed and hold it in place with a vacuum.
3. Use the off-contact screen printing method to produce a uniform impression. Make a fill pass and then make the impression pass.
4. Cure the ink within 5 minutes of screen printing. Delaying the curing process may cause an undesirable surface appearance.
5. Perform all of the tests as outlined in the "Testing" section on page 7.

Printing Order 4 Color Process

Generally, the printing order is yellow, magenta, cyan, and black in that order. Other color orders can work, however the order must be the same one used to prepare the color standards provided to the separator.

Color Control 4 Color Process

Producing a large number of multi-sheet, four color graphics requires good color control. Judging the color and density visually is NOT adequate. The following quality control tools are essential for obtaining a satisfactory yield of high quality graphics.

- Establish good, stable, screening conditions.
- Use a reflection densitometer equipped with a separation or graphic arts filter. Do NOT use Status A, M, T, or SPI color filters.
- Use an approved proof from the color separator with a color bar or a series of printed color progressives accepted by the customer. The progressives should each be made with the same ink and at the same gloss as the proof. Match the density readings from the print job to the color bars on the proof or color progressives.
- Use the density measurement from the approved proof or color progressives as a target for the first color. If neither of these is available, use the following suggested target densities.

Color[1]	Target Density
Yellow	0.90
Magenta	1.35
Cyan	1.30
Black	1.60

[1] Assumes a print sequence of YMCK.

NOTE

Density values are relative to the substrate. The density of the substrate is read with the appropriate color filter in place and that value is subtracted from the reading obtained from the color bar. Adjust the densitometer to read "0" as the density for the substrate.

- Consider adjusting the density with Halftone Base 9800B if it differs from the target by more than 0.10 (0.05 compared to a progressive).
- The density of the first color establishes density targets for the other colors. Adjust the original target density for subsequent colors by an amount equal to the difference between the first color and its target.

Example

Color Target	Target Density	Actual Measured	Difference	New Target Density
Yellow	0.90	0.81	-0.09	(actual)
Magenta	1.35	-	-0.09	1.26
Cyan	1.30	-	-0.09	1.21
Black	1.60	-	-0.09	1.51

NOTE

To preserve the color balance, make every effort to screen densities to within 0.03 of these new targets.

- Monitor the density of the color bars and selected areas of halftone dots throughout the print run.
- Any change in density indicates a potential problem that should be identified before the density drifts out of the acceptable range.

Screen Cleaning

Use a commercially-available screen cleaner. A blend of solvents such as xylol and methyl ethyl ketone can also be used. Screens that are NOT thoroughly cleaned may adversely affect print quality upon reuse.

Non-solvent screen washes must be tested. Some brands may cause ink to gel in the screen or reclaimed ink to contaminate unused ink.

Curing

Radiometer

The UV energy output of the cure unit must be accurately measured. Use a Uvicure® Plus II UVA/High Power model radiometer. This radiometer is available from:

EIT Corporation
108 Carpenter Drive
Sterling, VA 22170
Telephone: (703) 478-0700.

Calibrate your radiometer on a regular basis to ensure its readings are accurate.

NOTE

Other radiometers may not give the same readings.

Focused-lamp Cure Unit

Focused-lamp cure units use high concentrations of ultraviolet light to initiate polymerization. Ink Series 9800 inks are formulated to cure when exposed to a focused, medium-pressure, mercury-vapor lamp at a belt speed necessary to achieve the required energy output. Ink Series 9800 inks can be partially cured by stray light in and around a printing facility, such as skylights, windows, and overhead lights.

Use bulbs that produce light with wavelengths of 260 to 360 nanometers. Ozone-free and doped bulbs may not produce the correct wavelengths to properly cure Ink Series 9800 inks. Some quartz IR filters can also interfere with the ink curing.

Ensure energy levels are uniform across the entire web. When testing this uniformity, do NOT use belt speeds greater than 45 ft/min (13.7 m/min). Energy levels could be significantly lower at the web edges. Do NOT print graphics wider than the width of the uniform output of the bulbs.

Cure Unit Operation

1. Measure the UV lamp energy at the beginning of every working day and whenever adjustments are made to the unit.
2. Allow the lamps to heat up for at least 10 minutes or until the indicators show that the lamps have stabilized.
3. Replace bulbs according to the bulb manufacturer's recommendations. Dirty lamps and reflectors or bent reflectors prevent the ink from curing properly.
4. Adjust the lamp wattage and/or belt speed to get the specific energy level on the radiometer.

Products	UV Energy millijoules/cm^2 (mJ/cm^2)	UV Peak milliwatts/cm^2 (mW/cm^2)
Colors	200 to 275	600
9730UV	250 to 310	600
9740i	150 to 250	600
Clear 9800CL	250 to 325	600

NOTE

The radiometer measures in joules/cm^2. To convert, 0.001 joules/cm^2 equals 1 mJ/cm^2.

5. Test the clear to ensure it is properly cured. Test methods are outlined in the "Testing" section on page 7.
6. Adjust the unit until the clear is correctly cured.

Testing

Maintain a test log for future reference. Each print pass must be tested to determine if the ink or screen print clear is properly cured. Every print pass must pass these three tests.

- Appearance Test
- Abrasion Resistance Test
- Tape Snap Adhesion Test

Appearance Test

This test determines if the ink visually appears to be cured.

Frequency

Test before printing each color and applying the clear.

Surface Characteristics

Properly cured Ink Series 9800 inks should have these surface characteristics:

- Medium to high gloss for the inks; high gloss for the clear
- Smooth ink surface
- No wet or overly tacky areas

Abrasion Resistance Test

This test determines if the ink is undercured.

Frequency

Test in several areas on the sheet before printing each color and applying the screen print clear.

Procedure

1. Make press adjustments to produce an acceptable wet (uncured) print.
2. Print a production sheet of film and pass it through the UV curing unit.
3. Try to smear the ink by twisting your thumb on the surface of the graphic.

NOTE

Always wear protective gloves to protect your skin from uncured ink and prevent skin oils from influencing the outcome.

4. Implement the following adjustments as necessary if impressions are made on the ink surface:
   a. Ensure the press conditions follow the recommendations.
   b. Reduce the ink thickness.
   c. Use a harder squeegee.
   d. Set the squeegee angle closer to vertical.
   e. Increase the energy level by slowing the belt speed slightly.
5. Repeat Steps 2 to 4 until the ink passes the Abrasion Resistance Test.

Tape Snap Adhesion Test

This test determines the cure of:

- Each color and trap on the film if a clear will not be applied
- Clear over each ink color
- Clear over bare film
- Clear over color traps (ink layers)

Passing the sheet through the curing unit several times may change the surface characteristics of the ink and film. Testing simulates the process and allows for adjustments to prevent graphic failures.

Frequency

Test in several areas on the sheet before printing each color and before applying the clear.

Procedure

1. At the beginning of the print run:
   a. Print and cure the first color.
   b. Pass the sheet through the cure unit two times more than the number of colors that are left to print. For example, if one color remains, pass the sheet through the unit three times.
   c. Offset the sheet.
   d. Reprint the ink so it prints over the previously printed color and on the bare film. This simulates printing a clear layer.
   e. Cure the graphic with four passes at the ink energy level to simulate the clear.
   f. Test the ink according to the instructions in Step 2.
2. At the beginning of each color or clear pass:
   a. Use the point of a sharp razor blade, knife, or another suitable instrument to scratch a crosshatch pattern through the ink. Do NOT cut into the film. Be sure to scratch areas where the clear is applied over each printed ink layer and the film.
   b. Use a 3M™ Hand Applicator PA1-G Gold to firmly apply 1 in. (2.5 cm) wide Scotch™ Tape #610 over the crosshatched areas.
   c. Remove the tape by pulling it back upon itself using a firm, rapid pull.
   d. No separation should occur between the inks, or between the inks and the film.
   e. If the ink separates, decrease the energy level by increasing the belt speed slightly and retest.

NOTE

The ink must still pass the Abrasion Resistance Test and Appearance Test after any adjustments are made.

Special Applications

Use of Continuous Multi-Station Presses

A multi-station press automatically moves a sheet from one press and cure unit to another. Because sheets cannot easily be removed from between the presses, performing the standard tests is difficult or impossible.

If the printing finishes after one pass, perform the Abrasion Resistance Test and the Tape Snap Adhesion Test at the end of the pass. Test the sheet on the left, right, top, and bottom edges, plus several places in the middle. Test all of the following combinations of ink colors, clear, and film:

- Clear over each ink color
- Clear over bare film
- Clear over color traps (ink layers)
- Each color over each film combination if a clear will not be applied

Call 3M Technical Service for guidance if processing the sheets requires more than one pass through a multi-station press.

Roller Coating

Although 9800CL UV Clear is designed for screen printing, it can be roll coated. The process must produce the 3M recommended coating thickness of 10 to 15 microns across the entire graphic, with a gloss and an appearance acceptable to the end user. Achieving the correct thickness is critical. If the coating is too thin, it will not have the expected durability; if it is too thick, the coating will reduce the film's ability to stretch and conform.

3M UV clears are high viscosity solutions that require appropriate handling equipment, and may require adjustments to flow properly. Do NOT thin the clear coat or add any components (such as flow agents) that have not been approved by 3M.

3M does NOT recommend or endorse a specific roll coater, nor does 3M make specific recommendations on how to make 3M UV clears more suitable for roll coating.

Metallic and Pearlescent Inks

Producing graphics with ink containing metallic and pearlescent flakes requires careful attention to produce consistent, high quality graphics. Even small changes in components and processing conditions affect the print quality.

Warranted Metallic Flakes

The recommended aluminum flakes are a "non-leafing" type and are dispersed in mineral oil. Their disk shape provides a specular-like appearance and may have a whiter appearance than other flakes.

Do NOT use larger flakes, as these are difficult to screen print and may produce graphics with an inconsistent appearance.

Use only the recommended flakes. Other flakes may not be outdoor durable.

Specifically request coated flakes, as both coated and uncoated flakes have the same part number. The aluminum in metallic flakes can catalyze UV-cured inks, causing the ink to thicken rapidly, affecting color consistency and reducing pot life.

NOTE

Sparkle Silvex™ Aluminum Flakes are available from:
Silberline Manufacturing Company Inc.
130 Lincoln Drive, P.O. Box B, Tamaqua, PA 18252-0420
Telephone: 570-668-0197

NOTE

Nazdar® Aluminum Flakes are available from:
Nazdar Inks & Coatings
8501 Hedge Lane Terrace, Shawnee, KS 66227-3290
Telephone: 913-442-1888

Flake Size	Sparkle Silvex™ Aluminum Flakes
Small	SSP-950-20-C
Medium	SSP-910-20-C or SSP-404AR

Flake Size	Nazdar® Metallic Flakes
Fine	SIPM 573
Small	SIPM 606
Medium	SIPM 571

Flake Deterioration Issues

NOTE

Metallic flakes require special handling. Exposure to air causes them to deteriorate and agglomerate. This will cause printing problems. 3M recommends buying only what can be used in a short period of time.

The recommended flakes have an unopened shelf life of one year from the date of manufacture. However, each time the container is opened, the flakes are exposed to oxygen and moisture, degrading the flakes and shortening their shelf life. As the flakes oxidize, they agglomerate, or clump together. Agglomerated flakes appear darker, have less hiding power, and have less specularity than non-agglomerated flakes. The screens used in the printing process tend to filter out agglomerations. These factors reduce ink lay down and change flake concentrations, causing color changes throughout the print run.

How to Determine if Flakes are Deteriorating

1. Upon receipt of the flakes, prepare a known concentration: 5% or 10% of flakes in Toner 9810.
2. Print this mixture on a clear substrate such as 3M™ Controltac™ Graphic Film IJ180mC-114.
3. Apply the printed sample to a piece of glass. This is your standard.
4. Each time you use flakes from the same container (in the same concentration), compare the standard to the new prints. Look for a change in hiding power and color consistency. Operators must determine for themselves what is acceptable quality and what is not.

How to Protect the Flakes

Limiting the flakes' exposure to air and moisture is the best defense against deterioration. To help protect the flakes:

- Order a smaller container of flakes.
- Repackage the flakes into quantities typically used for one print run. Use packaging similar to the original containers.
- Tightly reseal the container immediately after removing the flakes.
- Store the flakes at 50°F to 80°F (10°C to 27°C).
- Avoid high shear mixing. This can also cause flake agglomeration.

NOTE

The ink must still pass the Abrasion Resistance Test and Appearance Test after any adjustments are made.

Warranted Pearlescent Flakes

Pearlescent flakes are a stable, multi-layer metal oxide. Compared to aluminum flakes, the pearlescent flakes have a subtle specularity and they do not muddy the color of Ink Series 9800 inks. Although there is some sparkle to pearlescent flakes, it is usually only visible in sunlight.

Pearlescent flakes come in a variety of colors including but not limited to white pearl, red, violet, bronze, yellow, blue, and green. Colored inks are used with pearlescent flakes to achieve the color. Not all pearlescent flake colors have good outdoor durability.

Do NOT use large flakes, as they are difficult to screen print and may produce graphics with an inconsistent appearance. Use only the following pearlescent flakes.

Flake Size	EMD Chemicals Part No.	Effect
Small	9111 WR Rutile Fine Satin	Luster
	9121 WR Rutile Luster Satin	Luster
Medium	9103 WR Sterling Silver	Similar to small to medium aluminum flakes, except they have no opacity or hiding power

NOTE

These pearlescent flakes are available from:

EMD Chemicals, Inc., Performance Materials Division
One International Plaza, Suite 300
Philadelphia, PA 19113
Telephone: 484-652-5600

Mixing

1. Follow these concentration recommendations.

Type	Maximum Concentration By % Weight	Typical Concentration By % Weight
Metallic Flakes	15	5 to 10
Pearlescent Flakes	15	10 to 15
Mixtures of Metallic and Pearlescent Flakes	15	5 to 10

2. Use a power mixer. Do NOT use a cowl blade dissolver or any other high shear mixer. These can cause the flakes to agglomerate.
3. Gradually add the flakes to the ink and mix until the flakes are evenly blended into the ink.
4. Inks must be mixed frequently to keep flakes from settling.
    - Increasing the flake concentration increases the viscosity. To decrease the viscosity, add less than 10% by weight of Thinner 9801.
    - Adding 5% to 10% by weight of Halftone Base 9800B gives the ink body and slows the rate at which flakes settle. This helps maintain more consistent color throughout the print run.
    - If there is any colored ink in the formula, limit the combined amount of Thinner 9801 and Toner 9810 to 80% by weight.
    - If there is no colored ink in the formula, there are no limitations on the amount of Thinner 9801 and Toner 9810.
    - Adding more than 10% to 15% by weight of opaque ink prevents the ink from curing correctly. Operators must balance the amount of flakes and the amount of opaque ink to allow the formulation to cure properly.
    - Using opaque inks increases the ink formulation's opacity, but decreases its specularity and perception of depth.

Screen Printing with Flakes

- Use the same screen printing method for metallic and pearlescent inks as for regular Ink Series 9800 inks.
- Mesh size is critical. Openings that are too small do not allow all the flakes to go through, causing the color to shift. Openings that are too large deposit ink too thickly, interfering with curing. The theoretical ink volume should be less than 0.48 $in.^3$/sq yd (9.4 cm^3/sq m).
- Follow these mesh size recommendations:

Type	Flake Size	Flake Size (microns)	Mesh Size
Sparkle Silvex™ Metallic Flake	Small	19	34 micron or larger; 355 to 390 tpi plain weave
	Medium	22	34 micron or larger; 305 tpi plain weave
Nazdar® Metallic Flake	Fine	N/A	Recommended meshes for printing metallics are 305 to 355 tpi plain weave monofilament polyester.
	Medium	N/A	
	Coarse	N/A	
EMD Chemicals Pearlescent Flake	Small	< 20	34 micron or larger; 355 to 390 tpi plain weave
	Medium	10 to 40	34 micron or larger; 305 tpi plain weave

- Inks must be mixed frequently to prevent flakes from settling.
- Ink must be mixed before adding it to the screen, and then thoroughly mixed with the ink already in the screen.
- Both types of flakes increase the wear on the squeegee and the screen.

Curing Metallic Inks

- Curing metallic inks from Ink Series 9800 may be more difficult if flake concentrations are greater than 15% by weight. To cure properly, the inks may need a higher energy level than the recommended 200 to 275 mJ/cm^2 target. When using higher energy, the Tape Snap Adhesion Test becomes even more critical.
- Cured metallic ink is initially softer and tackier than ink without flakes. Gradually increase the energy level until the ink does not easily scrape off of the film. The ink hardens in about 2 hours.
- Increasing the flake concentration to more than 12% by weight makes the ink softer.

Pot Life Metallic Inks

- After adding the metallic flakes, the pot life of metallic ink is one to two days, after which time the ink begins to gel. How fast an ink gels depends on the flake concentration, the storage temperature, the formula, and the mixing conditions.
- Pearlescent flakes do not cause ink to gel. However, pearlescent flakes do settle more rapidly than metallic flakes.

Testing Graphics Printed with Metallic Inks

- The appearance will not be as glossy because of the surface texture.
- The initial ink softness may result in ink scraping off more easily during the Abrasion Resistance Test.
- Ink formulations with a high flake concentration may split within the ink layer during testing. If this happens, reduce the flake concentration.

Health and Safety

Tools and Equipment Usage

When using any equipment, always follow the manufacturer's instructions for safe operation.

Chemicals

When handling any chemical products, read the manufacturers' container labels and the Safety Data Sheets (SDS) for important health, safety, and environmental information.

Follow this link to obtain SDS sheets for 3M products.

Follow this link to obtain information about substances of very high concern (SVHC) for EU products.

Ventilation

Provide local and/or general exhaust ventilation in print production areas to prevent a build up of ink vapors and to maintain levels below the limit for worker exposure. An experienced industrial ventilation engineer and/or a certified industrial hygienist can help evaluate your ventilation requirements and design based on your on-site process conditions.

Refer to the printer manufacturer's literature for additional details and requirements.

Air Quality Regulations

Country, state, or regional volatile organic compound (VOC) regulations may prohibit the use of certain chemicals with VOCs in graphic arts coatings and printing operations. Check with local environmental authorities to determine whether use of this product may be restricted or prohibited.

Warranty Information

Technical Information

Technical information, guidance, and other statements provided by 3M are based upon records, tests, or experience that 3M believes to be reliable, but the accuracy, completeness, and representative nature of such information is not guaranteed. Such information is intended for people with knowledge and technical skills sufficient to assess and apply their own informed judgment to the information. No license to any intellectual property rights is granted or implied with respect to this technical information.

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