Screen Printable UV Curing Pressure Sensitive Adhesive SP7202

Process Guide for Screen Printing and UV curing **January, 2022**

Safe Handling of UV Materials

What is Product Responsibility?

Product Responsibility means protection of the environment, health, and safety (EHS) in every aspect of product manufacture, use and disposal. Life Cycle Management (LCM) is one process used at 3M to help understand and manage the EHS impacts. LCM stresses the efficient and safe use of resources in 3M products throughout their life cycle to guide responsible design, development, manufacturing, use, and disposal. 3M's product responsibility principles and practices support our fundamental corporate values, help achieve both legal compliance and ethical business conduct, and contribute to successful product commercialization and customer satisfaction.

About this Document

This document is not intended as a substitute for obtaining, reading, and following the appropriate Safety Data Sheets (SDS), the 3M Product and Instruction Bulletins for the Screen Printable Adhesives you are using, or the instructions provided by the manufacturer of any other equipment of chemicals used.

⚠ Caution

When handling any chemical products, read the manufacturers' container labels and the Safety Data Sheets (SDS) for important health, safety and environmental information. To obtain SDS sheets for 3M products go to 3M.com.

Read and follow the most current 3M Product and Instruction Bulletins for the Screen Printable Adhesive you are using. They are available at 3M.com/converter.

Introduction

For many years, ultraviolet (UV) curing has been successfully used as an environmentally friendly, low VOC coating, and adhesive technology. UV materials can be handled safely if the proper handling/training and industrial hygiene practices and engineering controls are utilized.

UV curing materials contain little to no VOCs and typically contain no hazardous air pollutants (HAPS). They are not typically specified in any federal or state Community Right-to-Know list.

Incomplete curing of the printed substrate can cause uncured components to be present on your part. Substrates where adhesive can penetrate below the printing surface may be difficult to adequately cure. Please take the appropriate measures to ensure that your adhesive is fully cured.

Handling

In general, acrylates found in UV materials tend to be on the high side of the irritation scale. Clearly defined work procedures and effective worker training are essential when working with these materials. Safe handling principles may prevent an allergic skin reaction, or in certain individuals, sensitization over time. Experience has shown that good procedures and worker training in handling and industrial hygiene practices enable UV curing systems to be used safely in a wide range of industrial applications.

As with any chemical, food and beverages should not be consumed in areas where UV curing materials are handled.

Minimizing the Risk of Contact

Most people can work safely with UV curing materials by using the proper protective clothing and handling procedures. It is important to remember that UV curing materials do not evaporate, so spills and incidental contamination will remain until cleaned up. For example, equipment touched with contaminated gloves can be the source of exposure if touched later by unprotected skin. Always remove any contaminated personal protective clothing prior to leaving the work area.

Protective Clothing

The type of protective clothing recommended depends on the type of potential exposure and materials involved. The typical clothing would include:

• Woven or non-woven, long-sleeved, full-leg clothing or coveralls should be worn.

• Gloves should always be worn when direct contact with materials is anticipated. They should be selected to be resistant to prolonged contact with UV materials and cleaning or diluting solvents. Polymer laminate gloves are some of the most effective barriers for this type of material. Follow the glove manufacturer recommendations for glove changeout or consult with your EHS representative. Barrier creams can be used with gloves. They should not be used alone to provide protection. Barrier creams should be applied to clean skin and not applied after exposure.

• A rubber apron or rubber suit is appropriate when the possibility of splashing with solvent or corrosive materials exists. Frequent washing of the hands and arms with soap and water is a good practice.

• Shoes must provide full foot coverage. Rubber boots should be worn when there is a possibility of working in solvent or liquid chemicals or in situations when a bulk spill could occur.

Exposure

Physical skin contact and eye exposure are the primary concerns when working around UV light sources.

UV curing acrylates can cause skin irritation, dermatitis and chemical burns or blisters after prolonged contact. Some individuals may become sensitized as a result of contact with UV materials. If sensitization occurs, immediate removal of the individual from the exposure areas is recommended.

Refer to the SDS for additional details.

Ozone Generation

UV-curing units create energy and can also cause oxygen in the air around the curing zone to form ozone. High concentrations of ozone can cause shortness of breath, coughing, wheezing, headaches, nausea, and eye and throat irritation.

Ensure that there is adequate ventilation and extraction of air from the curing area of the UV dryer. Curing units typically come with ventilation fans. However, it may be necessary to install supplemental extraction fans in the ventilation system or remove the oxygen from the curing zone of the dryer. Consult a qualified local industrial hygienist.

UV Curing Lamps

Ultraviolet light from a commercial UV curing lamp is considered carcinogenic. Shielding is required to protect workers and bystanders from the UV rays. Manufacturers of equipment normally include such shielding in their designs.

Odor

The only byproduct of the UV lamp is ozone gas. It has a pungent sweet odor and is distinctive enough that concentrations well below the threshold limit value (TLV) of 0.1 ppm are noticeable. At high enough concentrations, ozone gas and odors can cause headaches and fatigue. After repeated exposure at high concentrations, ozone can cause dryness of the upper respiratory tract, pulmonary irritation, and possibly respiratory infections. Exposure to ozone gas can easily be avoided with spot collectors and proper ventilation adjacent to the UV curing unit as well as with lamps to draw the ozone away from the operators.

Most UV curable materials are based on acrylate resins, which have a distinctive smell. Odors are not necessarily a cause for concern. Relatively nonhazardous materials can have a strong odor, and conversely very hazardous materials can be odorless. Although odiferous materials can be a nuisance in the workplace, odor is usually not a concern unless the material detected is an inhalation hazard. To minimize odors, the workplace and associated equipment should have proper ventilation maintained to the material supplier’s specifications. Air flow tests can be easily conducted to determine equipment status. The acrylates in UV materials typically have low odor thresholds and, therefore, their odors are detected at very low concentrations.

Material Transfer and Storage

Equipment which minimizes direct contact with workers should be used for material transfer whenever possible. UV curing materials should be stored in containers which prevent exposure to light and UV sources and should be kept away from oxidizing agents, acids, alkalis, catalytic metals, and polymerization initiators.

Clean-up

Because UV curing materials do not dry out or cure under normal ambient conditions, they remain liquid and can be cleaned up easily with appropriate screen cleaners and solvents*. It is recommended to clean the screen mesh with automatic cleaning equipment. When cleaning manually with solvents*, always ensure good room ventilation and that the appropriate protective clothing is worn. Solvents should not be used to wash the skin because they may increase the possibility of penetration of chemicals into the skin, and dermatitis may occur. Hand creams should be used to prevent irritation of the skin due to frequent washing.

***Note:** Carefully read and follow the manufacturer's precautions and directions for use when working with solvents. These cleaning recommendations may not be in compliance with the rules of certain air quality management districts in California; consult applicable rules before use.

Waste Disposal

Adhesive waste or prints with wet adhesive must be disposed of in accordance with applicable regulations. Curing prints and print waste before disposing of them is highly recommended. Incineration is the most viable method used. Users should find a reputable, approved company to handle incineration. Unless diluted with flammable solvents, UV curing materials generally are not "hazardous waste" under RCRA regulations. However, as with all chemicals, contaminated materials and wastes should be disposed of in accordance with federal, state, and local requirements.

Contaminated Clothing

Consult the SDS for proper disposal considerations. Also consult your local waste disposal authorities for guidance.

If you get UV materials on your skin or clothing, immediately remove all contaminated clothing. Wash the affected skin areas thoroughly with mild soap and water or with materials specially designed for that purpose. Do not use abrasive cleaners. Solvents should not be used as they may increase the penetration of monomers into the skin. Continue to flush the skin with lukewarm water for 15 minutes to ensure the material is completely removed.

Contaminated work articles or clothing should be thoroughly cleaned or discarded. Protective clothing contaminated with small amounts of UV curing materials can be laundered in an alkaline detergent and reused. If protective clothing becomes heavily contaminated, it should be properly discarded. Use of an industrial laundry equipped to handle chemical residue is recommended. Do not take contaminated clothing home for cleaning.

Contaminated shoes, belts, or other leather goods cannot be decontaminated to allow safe use and should be discarded.

Conclusion

Good industrial hygiene practices, knowledge of safe handling procedures, and worker training are essential for safe handling of any chemical. When these principles are followed, UV curing technology can be handled safely in industrial applications.

Disclaimer

This bulletin conveys environmental, health and safety information for a product. The information provided is accurate to the best of our knowledge but is not intended to be exhaustive. Additional safety and regulatory information can be found at 3M.com/regs. Distributors and users of 3M products remain responsible for complying with all applicable laws and regulations.

Material Information

Form and Appearance

SPX is a thixotropic liquid that is colorless and clear. Viscosity increases when at rest thus allowing the screen to hold the adhesive when idle, as well as yielding dimensionally stable printed patterns after printing and prior to curing.

Dilution and Additives

SPX is ready for use directly as shipped. Dilution of the adhesives or the use of additives (e.g. defoamer) is **not recommended** as this may reduce adhesion or inhibit cure.

Agitation

Agitation is not required; phase separation is usually not to be expected in the shipped product. Agitation leads to a short-term reduction in viscosity, which facilitates pouring and distribution to the screen. Agitation may induce air entrainment or bubbles into the adhesive.

Note: Uncured adhesive can be returned to the container and reused.

Storage and Shelf Life

Store SPX in the original container. Keep the container tightly capped during storage. Avoid exposure of adhesive to direct sunlight and other UV-light sources.

The minimum shelf life of the adhesive is 18 months from date of manufacture when stored in original container and temperature should not exceed 40 °C.

See container label for further information.

Printing Guidelines

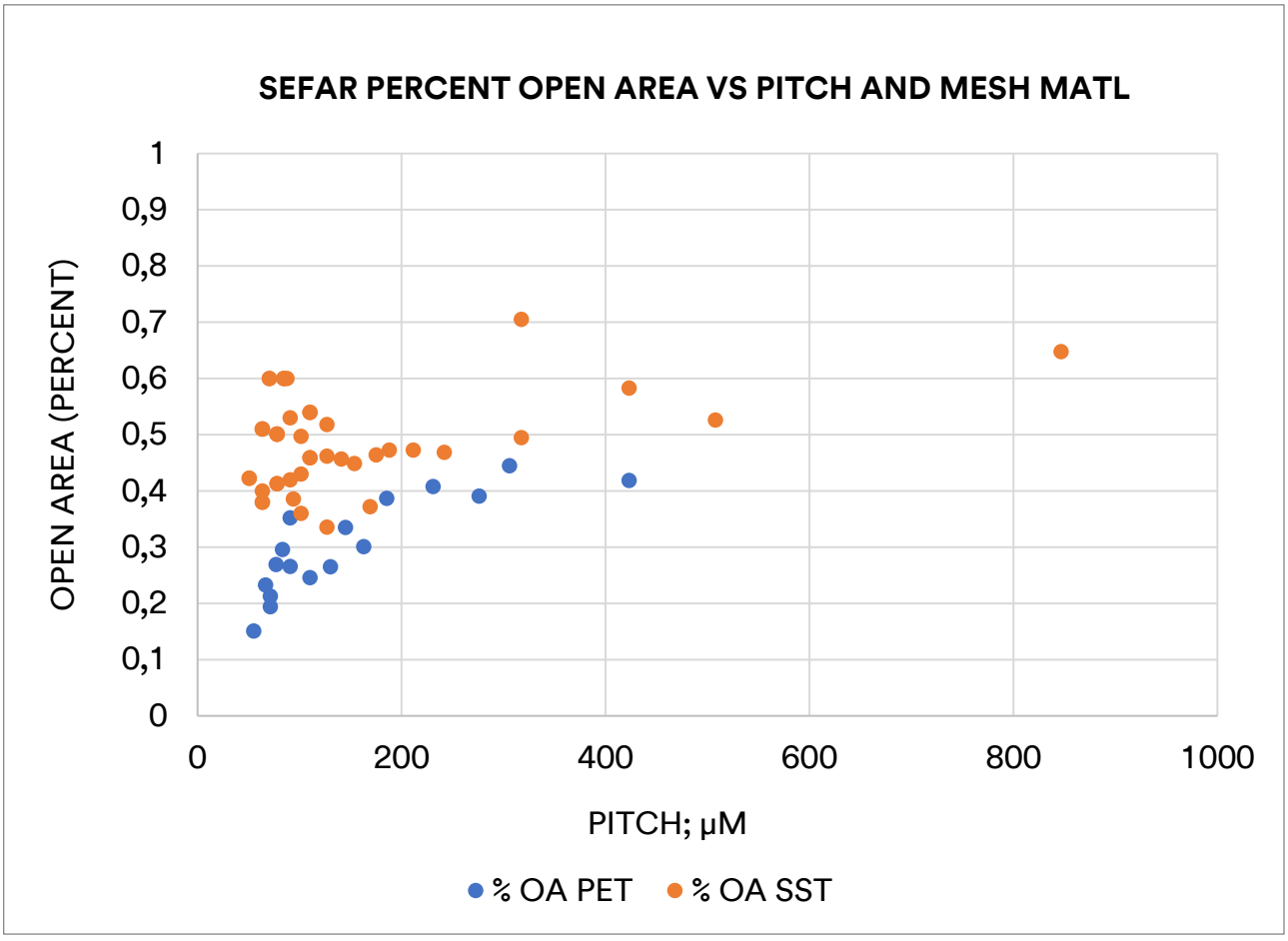
Screen Fabrics

Select screen mesh based on the required thickness of adhesive coating and printing precision.

Materials

Stainless steel, polyester, and nylon are suitable materials for the screen. Stainless steel will result in a thicker coating due to its larger mesh size and greater open area and generally provides a smoother adhesive top surface.

Polyester and nylon mesh are suitable for achieving precise patterns because of their finer thread diameter but as thicker caliper is desired can increase surface roughness.



Mesh Count and Adhesive Consumption

Unprocessed UV pressure-sensitive adhesives have a solids content of 100%. They do not contain organic solvents or water. Therefore, when selecting the mesh and calculating consumption, the wet thickness will equal the cured dry thickness of the finished product.

Table 1 illustrates the relationship between adhesive thickness, mesh count, and mesh diameter. The values listed can be used as guidelines for choosing the screen. Other parameters can also impact the thickness therefore the caliper during actual printing should always be verified. Table 2 illustrates the expected coverage for a given thickness of adhesive.

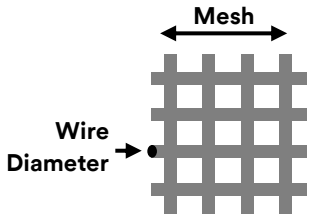


Table 1 - Adhesive Caliper vs. Mesh Count and Wire Diameter SEFAR screen portfolio

Mesh Material	Mesh Count		Thread/ Wire Diameter (µm)	Theoretical SP7202 Coating Thickness (µm)
	Threads/inch (LPI)	Threads/cm		
Stainless Steel	30	12	165	100
Stainless Steel	60	24	114	80
Stainless Steel	80	32	94	65
Stainless Steel	105	41	76	50
Stainless Steel	150	59	66	35
PET 1500	40	16	200	110
PET 1500	45	18	180	90
PET 1500	54	21	140	70
PET 1500	60	24	140	60
PET 1500	83	32	100	50
PET 1500	110	43	80	35
Example: For printing parameters in order to achieve higher adhesive thicknesses at a given screen mesh: Rounded squeegee blade shape, small set angle (e.g. 55 – 60°) in combination with a high squeegee speed.				
A contrary effect is a result of high squeegee pressure on soft printing substrates (e.g. polyethylene films)				

Table 2 - Printed adhesive area coverage as a function of adhesive caliper and quantity used.

	Coverage in square meters			
Adhesive thickness (µm)	1 liter	5 liters	10 liters	200 liters
20	48	238	475	9500
25	38	190	380	7600
30	32	158	317	6333
35	27	136	271	5429
40	24	119	238	4750
45	21	106	211	4222
50	19	95	190	3800
60	16	79	158	3167
70	14	68	136	2714
80	12	59	119	2375
90	11	53	106	2111

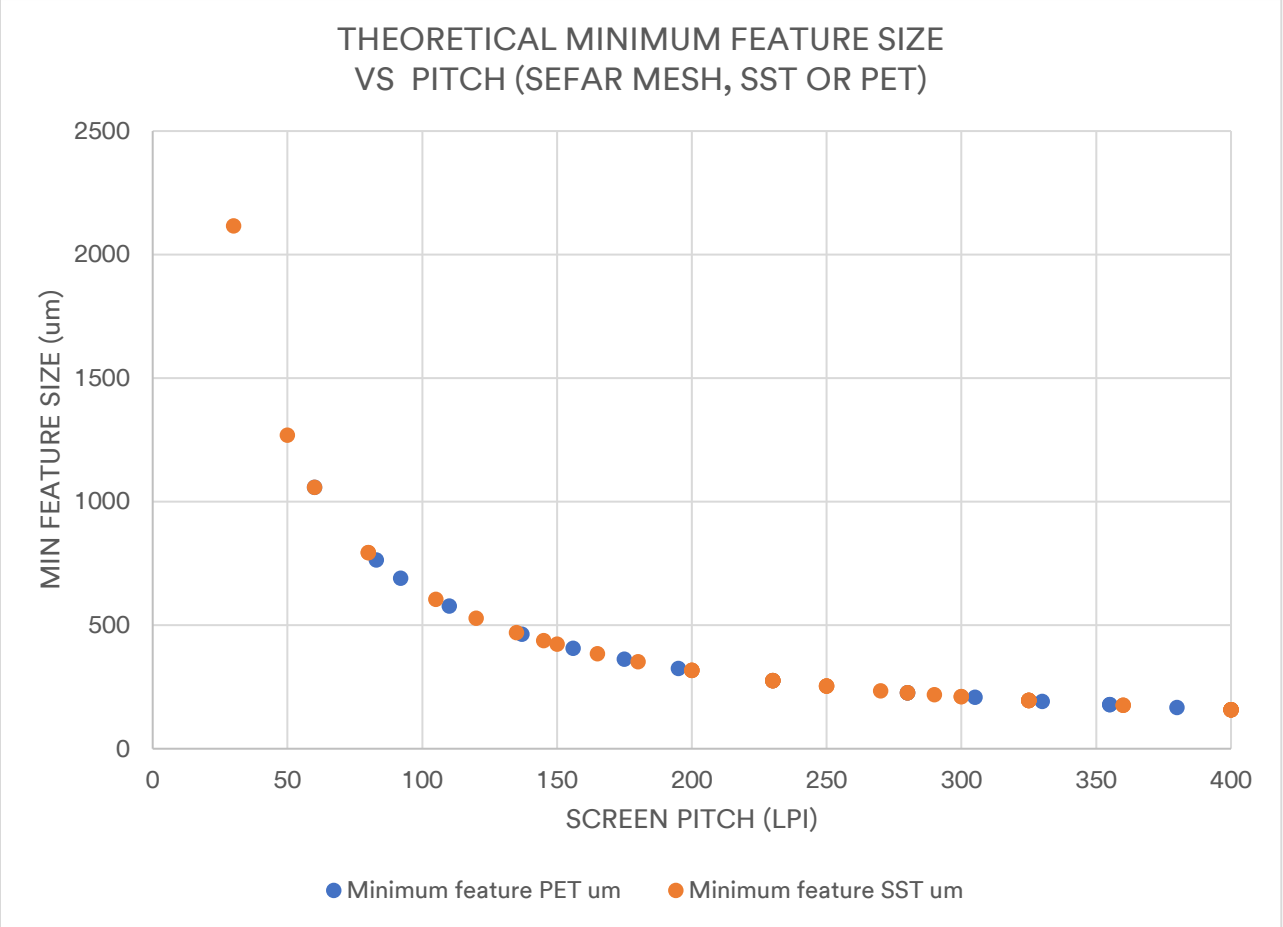
Stencil Materials (emulsion / capillary film):
Stencils should be made from materials that are typically used for UV adhesives, UV inks and solvent-containing pastes. Do not use stencils intended for aqueous adhesives.

Stencil Thickness:
The thickness of the stencil should be 30 to 70 µm greater than the thread diameter. A thinner stencil will result in lower coating weight, while thicker masking may impair the uniformity of the pattern at its edges, especially in broader patterns

Screen Design

Screens should be designed to limit large flood areas. Squeegees will drop into large flood areas and scoop adhesive out thereby leaving lower caliper sections of print. In place of flood areas, use a line as a border and fill the flood areas with dots.

Minimum part feature size is dependent on adhesive caliper. The thinner the caliper, the narrower the features that can be printed. The chart below illustrates this effect.



Printing Parameters

Printing SP7202 requires a balance between a number of factors in order to achieve good printing results. Table 3 shows the main parameters and their potential affects.

Table 3 – Parameters Which Can Affect Print Quality

Parameter	Effects and/or Recommendations
Squeegee	Polyurethane, RKS, sheet metal spring, depending on printing process and job.
Shape of Squeegee Blade	Various shapes are possible. A sharp blade edge results in sharper edge and top surface definition, while rounded blade edges lead to increased coating thickness, but also degradation of outline sharpness and top surface definition.
Hardness of Squeegee Blade	Shore A: 55–85. Many levels of hardness are possible. Harder rubber leads to reduced coating caliper and higher precision printing quality
Set Angle	Standard 75°. In practice, the print quality is primarily determined by the effective operating angle, not the set angle.
Operating Angle	The operating angle results from parameters such as hardness, thickness, profile, squeegee clearance, squeegee pressure and format. The amount by which the blade bends depends on these parameters. The stronger the bend, the smaller the operating angle, vertical force is higher, and more adhesive is squeezed into and through the stencil.
Squeegee Pressure	When squeegee pressure is too high, spreading of the adhesive is delayed. This can result in a structured surface texture when curing takes place shortly after printing.
Squeegee Speed	Squeegee speed is set in accordance with the format and desired release properties. Lower squeegee speed may improve adhesive release from the stencil as well as flowing on the substrate and a smoother top surface
Clearance (Off Contact)	Higher clearance improves the release of the screen from the sheet, but it also reduces positioning precision. Lower clearance supports the flow of the adhesive to a smoother surface.
Flood Bar (Scraper Blade)	Typically made of aluminum or stainless steel. The required distance setting may vary according to format and speed. In any case, uniform adhesive spreading must be ensured.

Printing Procedures

In order to ensure optimal flow properties, the temperature in the work area should be at least 21°C (70°F). The adhesive flow is temperature dependent, colder temperatures make the adhesive firmer which slows flow, conversely warmer temperatures soften the adhesive and facilitate faster flow.

UV pressure-sensitive adhesives allow the printing process to be interrupted for up to 3 hours; the adhesive does not cure in the mesh. After longer interruptions however, the first few prints should be discarded. Some light sources may emit UV which can shorten the open time or cause premature curing/gelling in the screen. UV filters over the light source may be used to minimize this impact. Skylights in the printing location should be avoided as they will accelerate cure.

Squeegee pressure should be increased if the printed outlines are poor or there are voids in the adhesive coating.

If the screen does not release from the substrate, increase clearance (off contact) and squeegee pressure accordingly

Applying Release Liner

If the printed adhesive is not intended for immediate application upon curing, it should be covered with 3M silicone coated release liner (5002 or 5002D for polyester film liners, or 4998 or 4997 for PCK Liners or similar). Apply the release liner without trapping air or contaminants after the adhesive has cured.

Other Printing or Coating Methods

SP7202 has been designed specifically for use with flatbed screen printing processes.

UV Curing Guidelines

UV Curing Chemical Reaction

UV Screen Printable Pressure-Sensitive Adhesives are similar to UV inks. They consist of monomers, oligomers, wetting agents, resins, photo initiators and rheological modifiers. During the UV curing process, the adhesive is converted from a liquid to form a polymer. Depending on the composition, this polymer cures to either a scratch-resistant hard finish (plastic), or a soft, viscoelastic pressure-sensitive adhesive.

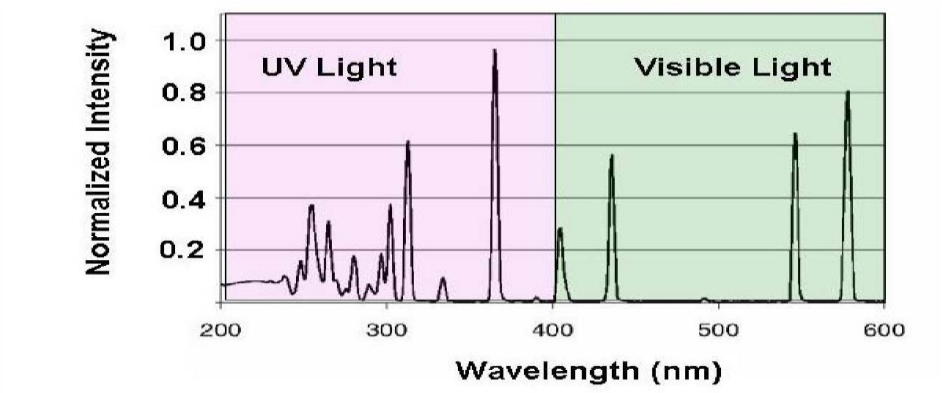
The reaction is triggered by the interaction of UV radiation with the adhesive chemistry. In addition, the type, total amount (Dose) and intensity of UV light will impact cure.

Use of the correct type of UV light source (lamp/bulb) is critical. The intensity of the UV lamps and the amount of radiated energy must be verified regularly by the printer with a radiometer before and/or during the curing process. This ensures simple and effective quality control.

UV Lamps (UV Spectrum)

Medium-pressure mercury arc lamps (also known as “H” Bulbs) are used to generate the UV light required for the curing process. This type of lamp is the one used most to cure larger areas. The use of the metal mercury and its defined vapor pressure inside the lamp ensure that specific, unvarying wavelengths of UV light are emitted if the lamp is used properly. The mercury vapor UV spectrum (see Figure 2) shows the wavelengths and intensities of the light emitted.

Figure 2



The UV spectrum is divided into the following three ranges:

UV A 315 to 400 nm

UV B 280 to 315 nm

UV C 200 to 280 nm

Some panel lights, however, use lamps in which the mercury vapor has been doped with metal halides (also known as “D”, “Q” and “V” bulbs). This changes the distribution of wavelengths (spectrum) and will change cure results. **SP7202 is formulated to work with mercury “H” bulbs and will not achieve full cure (unreacted chemistry) with doped “D” or “V” bulbs.**

Electrode or Electrodeless Lamps

Mercury lamps come in a few varieties for exciting the mercury: Electrode, Electrodeless (Microwave). Both options are effective for curing SP7202. Electrodeless lamps generally offer the following benefits than electrode lamps:

- Longer lamp life (generally 3 to 5x more than a standard electrode lamp)
- Higher efficiency light output, which generates less heat exposure for the adhesive and substrates.
- Instant on/off capability

Lamp Output / UV Intensity

The intensity of UV light, i.e., its radiation density, depends on lamp output and how strongly the reflector focuses the light. The minimum required radiation density is 0.3 Watts/cm², measured with a radiometer in the UV-A spectrum. This value can only be measured with a radiometer designed specifically for this purpose. It is not advisable to rely on the device data supplied with the UV curing equipment.

As a general guideline, it can be assumed that UV cure chambers with an electrical input of at least 80 Watts/cm of lamp length per lamp generate sufficient radiation density. The UV cure chamber should be set to 100 % lamp output.

Lamp fall off

The intensity of UV is highest in the center of the bulbs and falls off as it approaches the ends of the lamp. When curing large patterns, it is advisable to validate the UV dosage at both ends of the print to ensure proper dose.

LED UV Lamps

LED UV lamps should not be used for curing SP7202. LED UV bulbs emit narrow wavelength UV (e.g. 365 nm) which will only cure a portion of the adhesive. While SPX may appear to be cured, it will have uncured chemistry and low performance.

Process control

The following parameters are the primary factors for UV intensity:

1. **Type of lamp** (e.g. medium-pressure mercury vapor lamp)
2. **Type of device** (dryer output and type of reflector)
3. **Throttling of lamp output** (e.g. 100% output = 0% throttling)

Note: Since the above three parameters are fixed with the purchase of the UV cure chamber and the settings for the lamp output, the intensity of the lamp only has to be checked under certain exceptional conditions.

Two important factors to monitor are:

1. **Aging of the Lamp**: The intensity of the lamp begins to decrease after an operating period specified by the manufacturer, and it should be replaced at this time. The intensity also changes at the beginning of the lamp's lifecycle, which is why new lamps must be burned in (operated at full output) for a period of time specified by the manufacturer. The age of the lamps should therefore be monitored regarding operating hours.

2. **Dirtying of the Lamp or Protective Glass**: This is often caused by adhesive vapors. The maintenance plan should include a check to ensure that the glass of the lamp is clean.

Older lamps and / or poorly cleaned glass can result in a decrease of emitted UV energy, which is also a part of overall process control as described in the next section.

UV Energy and Process Control

For a given light intensity, the quantity of UV light required to cure the adhesive is governed by the total dwell time of the adhesive under the UV lamp, i.e., the speed at which it passes through the dryer/reactor. If two lamps are used instead of one, this speed can be doubled, and if three are used, it can be tripled. The distances between the lamps are irrelevant. The adhesives can also be cured by passing the print several times under one lamp to supply the required total amount of energy.

Measuring the total amount of UV energy is the critical process control factor. This is done by measuring the quantity of energy using a suitable UV radiometer and comparing this with the product specifications. If the measured value does not meet product specifications, the speed must be changed until the required energy level has been reached. The values specified by 3M are measured using radiometers manufactured by EIT. https://www.eit.com

Figure 1 EIT UV Power Puck II

Determining the UV Energy Cure Process Window for Your Equipment.

Unlike traditional UV cure inks, pressure sensitive adhesives need to have two function adhesive sides while also curing the bulk material. Under cured adhesive leads to low performance and potentially remaining a chemical, whereas over curing creates a very firm film with little adhesive performance. Due to the wide variety of UV equipment and lamps, it is necessary to create a profile for the cure of the adhesive on each UV reactor. Items that influence the UV cure process are bulb type, wattage, age, reflector type, lens type, focus type, focus distance, etc.

The cure window is determined by curing adhesive samples at multiple energy/dose increments. Once the cure sweep samples are made, they need to be peel adhesion tested to determine the proper cure window. This process is to ensure the adhesive is fully cured but not over cured.

Process for determining the cure window

- Target 50 um caliper samples.
- A minimum of 6 peel strips (1" x 6") per cure condition (energy) are needed. (3 replicates for faceside adhesion, 3 samples for liner side adhesion).
- Cure at the following energies (mJ/cm^2) of UVA: 200, 300, 400, 500, 600, 700 & 800
- Print the samples on clear PET liner and cover with a second liner. Liners should have enough release differential (minimum of 3:1 ratio) to permit easy removal without adhesive confusion.
- 180° Peel Adhesion testing to determine adhesion and failure mode.

The alternative to making a screen for the print cure sweep samples is to use a BYK box applicator/coater or similar to make wet film or “drawdown” samples.

BYK Box Applicator:
https://www.byk-instruments.com/us/en/Physical-Properties/Paint-Application/Manual-Film-Applicators/Square-Applicator---8-Gaps/c/p-5973

1. When using a box coater, double the thickness of your desired output to get the correct gap e.g., 50 um (2 mil) film thickness would need a 100 um (4-mil) gap.
2. Place a sheet of liner at least 400 mm (6”) and about 1 meter (39”) long with the tight side (high liner release side) facing up on a flat surface.
3. Place the BYK box coater on top of the liner at the end.
4. Place enough adhesive to make a draw down or film of adhesive the length of the liner inside of the box. A little adhesive goes a long way, but make sure there is enough to get the full caliper across the drawdown.
5. Press down on the box coater and draw it towards you at an even rate to create the drawdown.
6. Once the drawdown is made, send it through the UV reactor for cure.
7. Place an easy release liner on the top surface to protect it from contamination.

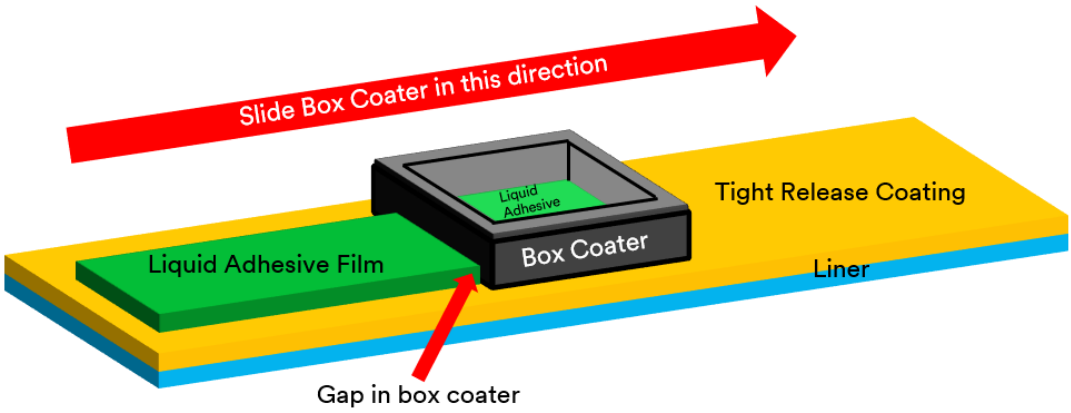


Figure 2 BYK Box Coater usage illustration

Peel Adhesion Testing the Cure Sweep Samples

Test Method ASTM D3330 Method E. or similar

- 180° Peel Angle
- Stainless steel substrate
- Primed 50 µm PET backing (primed with Primer 94 or similar material)
- 2,040 grams rubber covered roller
- 1 roll down at 600 mm/min in each direction
- 15-20 minute dwell time
- 23 °C 50% RH
- Peel Rate 300 mm/minute
- Faceside and Backside (liner side) to be tested
- Record average peel strength

Record Failure Mode

- Clean Peel – Peel is smooth and the adhesive removed cleanly from the panel.
- Shocky Peel – Adhesive removed cleanly from panel but it's peel was very shocky (start, stop, start, stop, not continuous).
- Cohesive – Adhesive split in half, even amount of residue left on both panels.
- Ply – Adhesive failure from both the stainless-steel panel and the primed PET backing. This is not a cohesive failure, but rather intermittent adhesion failure from both substrates.
- 2 bond - Adhesion failure from the backing, leaving all the adhesive on the stainless-steel panel.

The following is an example of a customer Cure Window Matrix: (for Review purposes only)

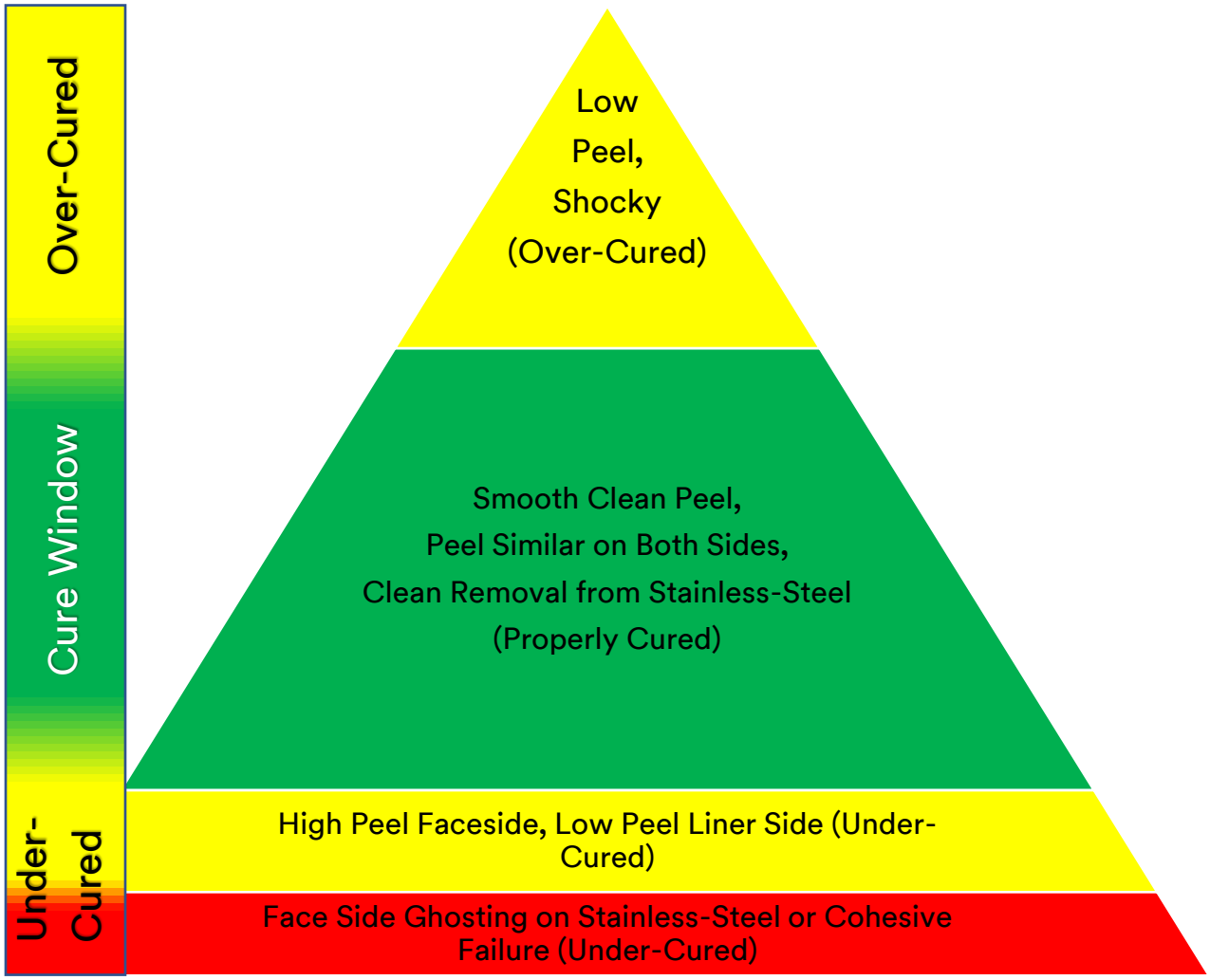
Cure Window Test Matrix

Cure level UVA (mJ/cm^2)	Face Side Adhesion (N/25mm)	Face Side Failure Mode	Liner Side Adhesion (N/25mm)	Liner Side Failure Mode
100	9,8	Cohesive failure	21,4	Cohesive failure
200	12,7	Cohesive failure	20,5	Cohesive failure
300	14,8	Cohesive failure	19,1	Cohesive failure
400	18,3	Clean peel	17,8	Clean peel
500	17,2	Clean peel	18,6	Clean peel
600	15,1	Clean peel	15,9	Clean peel
700	14,2	Schocky peel	12,9	Schocky peel
800	12,9	Schocky peel	8,5	Schocky peel

*Example of cure window matrix and failure modes.

Evaluation of the cure window test matrix.
Once the peel adhesion samples data and failure modes have been collected, the cure window can be determined. Compare the face side adhesion to that of the liner side for each energy level. Adhesion should be similar (not typically exactly the same) between the two sides.

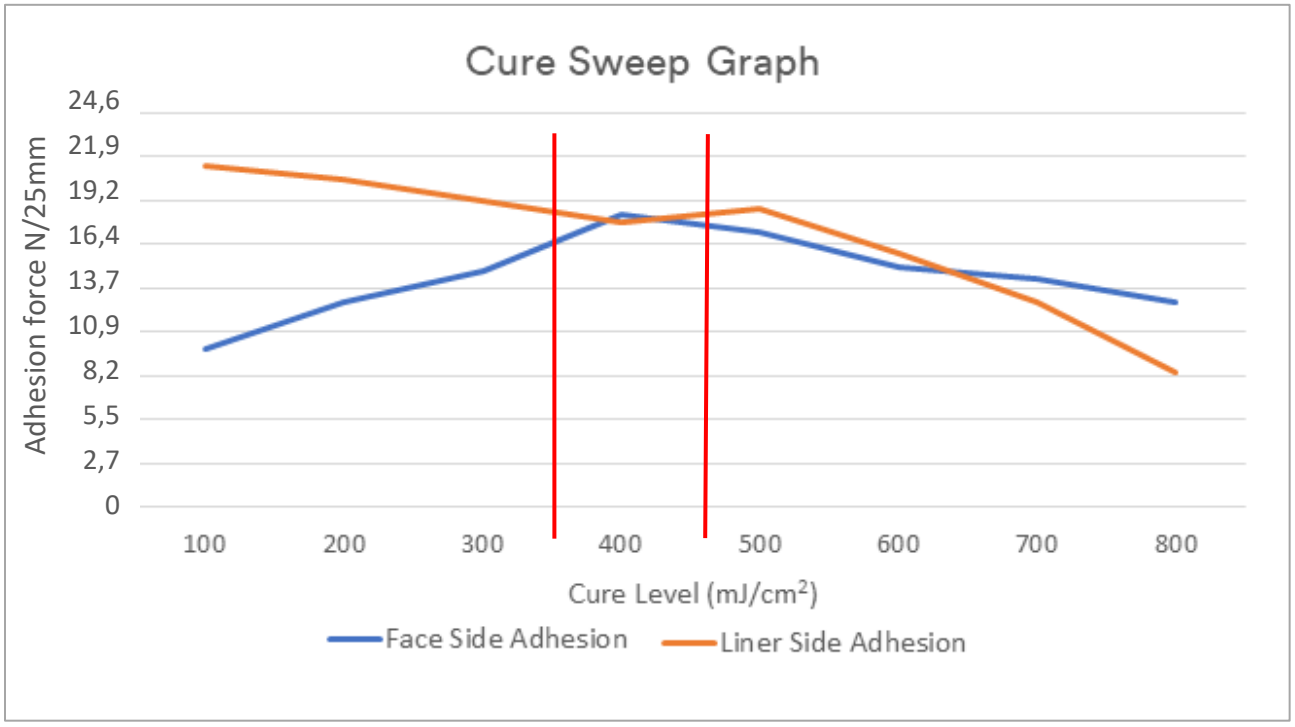
Peel results evaluation



- If peel results are cohesive failure the adhesive is under-cured.
- If peel results are ghosting on the stainless-steel panel, the adhesive is under-cured.
- If peel is smooth, cleanly removes from the stainless-steel and adhesion between the two sides are similar, this is the ideal energy dose to be using.
- If peel results values are low and shocky, the adhesive is over-cured, there is too much dose at this energy level.

Cure Sweep Graph

The below graph shows the output that comes from the Cure Sweep Test Matrix Data. The cure range (highlighted by red lines) that this customer should set their UV cure chamber to, is shown to be about 425mJ/cm^2 of UVA.



*Example of cure sweep graph

Summary of Key Production Parameters

Table 4 - Selection of UV Cure Chamber

Parameter	Recommendation
Type of lamp	Medium-pressure mercury vapor lamp
Reflector	Semi focused
Lamp Output	At least 80 W/cm
Cooling	As needed for highly temperature-sensitive substrates

Table 5 - Production Checklist

Parameter	Recommendation
UV-A-Energy	Check regularly with radiometer
Web Speeds	Document with radiometer readings
Lamp Glass	Check and clean as needed based on frequency of chamber usage
Lamp Aging	Check and replace as needed based on frequency of chamber usage

Recommended Process Conditions

Parameters:

Adhesive thickness is largely related to the screen mesh
Cure level or Dose (total energy) is largely related to the web speed and light intensity

Thickness and cure level are the key parameter to control the PSA-performance for 3M UV Curable Screen Printable Adhesives. In general, it can be said that the thicker the PSA thickness the better the adhesion and the more the PSA is cured, the higher is the shear strength.

The following table shows the process specifications for 3M SP7202. The Standard values shown in the table were used to determine the properties of the product as listed in the respective Product Data Sheet. The table also shows two additional recommendations to achieve special properties.

Table 6 – Energy Typically Needed for Desired Properties but depends on specific equipment please refer to your UV process window (Cure Sweep).

Adhesive Thickness (µm)	UV-A Energy (320-390 nm)
25 – 100 µm	**350-500 mJ/cm^2**
100 -200 µm	**450-650 mJ/cm2**

SP7202, Process Guide for Screen Printing and UV Curing

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