Secondary Imaging

LAMINAR DM
Dry Film SolderMask

LAMINAR DM Dry Film Solder Mask is an aqueous processable dry film photopolymer solder mask. LAMINAR DM Dry Film Solder Mask is a translucent green material which is supplied in thicknesses of 3.0 and 4.0 mils (75 and 100 microns). Like most other dry film products, the photopolymer is sandwiched between a 1.0 mil (25 micron) polyethylene release sheet and a 1.0 mil (25 micron) polyester support sheet.

LAMINAR DM Dry Film Solder Mask is recommended for printed wiring boards, rigid epoxy glass or polyimide laminates, with Cu, Sn/Pb, bright acid Sn or Au circuitry. LAMINAR DM Dry Film Solder Mask is compatible with most post soldering operations such as drag and wave soldering, as well as hot air and hot oil solder leveling. LAMINAR DM Dry Film Solder Mask will also withstand most aqueous and solvent defluxing media.

LAMINAR DM Dry Film Solder Mask is not recommended on flexible circuitry.

Processing Parameters

Processing of LAMINAR DM Dry Film Solder Mask consists of the following steps:

1. Preparation of PC board surface
2. Lamination
3. Exposure
4. Development
5. Cure

Copper

A clean copper surface is critical for good solder mask performance (copper adhesion after soldering). This is especially true when "hot air leveling" is to be used.
One method that has been proven to be acceptable consists of:

1 . Spray rinse with a 50% solution of sulphuric acid.
2. Thorough tap water plus D.I. water rinse.
3. Pumice scrub.
4. Thorough tap water plus D.I. water rinse.
5. Forced air blow dry.

Ideally, the copper surface should be cleaned just prior to solder mask application or within 2 hours.If boards are to be held for over 8 hours prior to solder masking, they should be recleaned.
The acceptability of the copper surface may be checked as follows:

1. Cleanliness - A clean surface should hold an unbroken film of water for at least 30 seconds.
2. Surface Area - A "surface profile" of the copper surface should show 18 to 24 peaks/100 microns with a score depth of 2.0 to 4.0 microns.

Fused Tin/Lead

The board must be clean and free from residual fusing fluids (fusing oils, fluxes, etc.). A recommended process is as follows:

1. Remove Fusing Fluids - After solder fusing, the board should be well rinsed (thorough hot water followed by cold water rinse). If a water rinse proves insufficient, either (a) a warm alkaline spray or dip cleaning followed by thorough water rinse, or (b) solvent, vapor or spray cleaning (i.e., 1,1,1-trichloroethane) may be required.

2. Mechanical Abrasion (if circuitry will tolerate) - (a) pumice slurry, as noted above, or (b) wet brushing with super fine Scotchbrite or equivalent.

Other Metallic Surfaces

1.Solvent Degreasing - Using a spray, dip or vapor degreaser, 1,1,1-trichloroethane works well.
2.Depending on the metallic surface, wet brushing, a pumice slurry or chemical cleaning may also be employed.

Drying

After the above treatments, oven dry the boards for 30 minutes to ensure total removal of surface moisture as follows:

1.Boards with Copper Circuitry - 150-170°F (66-77°C)
2.Boards with Other Metallic Circuitry - 220-260°F
(104-127°C)

A thoroughly dried board is critical for proper adhesion of LAMINAR DM Dry Film Solder Mask.

Lamination

LAMINAR DM Dry Film Solder Mask is best applied to the printed circuit board surface via appropriate vacuum lamination equipment such as the Dynachem vacuum applicator or the DuPont SMVL vacuum laminator. Hot roll lamination of LAMINAR DM Dry Film Solder Mask is not recommended because of potential conformation and air entrapment problems.

Solder Mask Thickness Selection

LAMINAR DM Dry Film Solder Mask is available in 3.0 and 4.0 mil (75 and 100 micron) solder mask thicknesses.

Thickness choice will depend on circuit geometry and circuit height of the printing wiring board. As a general guideline, circuits up to about 4.0 mils (100 microns) high can be successfully encapsulated utilizing 3.0 mil (75 micron) LAMINAR DM Dry Film Solder Mask. For circuit heights from 4.0 mils (1 00 microns) to 5.5 mils (138 microns), 4.0 mil (100 micron) LAMINAR DM Dry Film Solder Mask will be required. For circuit heights greater than 5.5 mils (138 microns), 4.0 mil (75 micron) LAMINAR DM Dry Film Solder Mask may sometimes be used successfully if adjustments are made to lamination temperatures, dwell times, etc.; however, complete circuit encapsulation cannot be guaranteed.

Recommended Lamination Conditions

Dynachem Vacuum Applicator

1.Cold roll, tack laminate with a suitable roll laminator, such as the Dynachem Model 360 DFSM and trim excess dry film solder mask from around the edges.This operation requires flat (not round) rollers, minimum pressure and no heat.
2.Place boards onto Dynachem vacuum applicator and press start button. Typical total cycle times range from 50-75 seconds.
3.Typical platen temperatures would be 170-200°F (77-93°C) for the top platen and 150-180°F (66-82°C) for the bottom platen. These platen temperature settings should yield board temperatures (top and bottom) of 140-160°F (60-71°C) using Dynachem Thermolabel temperature strips (Set #2, 140-180°F, 60-82°C).
4.After vacuum lamination, the boards should be racked in a vertical position to allow for cooling. Do not stack boards horizontally, one on top of the other.

Notes

1.Excessively hot board exit temperatures, excessive lamination temperatures and long lamination times may cause some solder mask polymerization. A symptom of polymerization is slow developing.
2.Boards should be at room temperature prior to the lamination Process.

DuPont SMVL Vacuum Laminator

1.Lamination Temperature: 80-100°C dial setting, yielding meter readings of 90-110°C (top platen) and 75-95°C (bottom platen).
2.Vacuum: Low (L-2) dial setting of 4.0 millibars and high (L-1) dial setting of 1000 millibars.
3.Cycle Time: 60-75 seconds total cycle time. This equivalent to 45-60 seconds dwell time in the vacuum chamber.
4.Board Exit Temperature: 145-155°F (63-68°C) as measured with a surface pyrometer or 150-170°F (66-77°C) using Dynachem Thermolabel temperature strips (Set #2, 140-180°F, 60-82°C).
5.Place boards in vertical position after trimming for cool down. Do not stack boards horizontally.

Exposure

Allow panels to cool to room temperature prior to exposure. A 30-minute period will accomplish this normalization.

Exposure time for the proper polymerization of LAMINAR DM Dry Film Solder Mask is a function of the type and intensity of the light source used, this must be determined empirically for each exposure unit employed.

Using a Stouffer 21 Step Sensitivity Guide (underneath the artwork for diazo film), the recommended exposure is clear metal showing at Cu 8 - 10. Resolution will be improved at the lower exposure level. Therefore, a clear metal Cu 8 will yield better resolution than a clear metal Cu10.

After exposure, hold the boards a minimum of 30 minutes prior to development.

Development

LAMINAR DM Dry Film Solder Mask can easily be developed in suitable conveyorized or spray developer units. Follow the developing step with a thorough water rinse.

LAMINAR DM Dry Film Solder Mask can be developed in either a total aqueous or semi-aqueous mode as follows:

Total Aqueous Developing -

Developer Chemistry Make-up: 1 % aqueous solution of sodium carbonate monohydrate or potassium carbonate or a solution of 29 parts water and 1 part Dynachem KB-1-A Developer.

Temperature: 100-110°F (35 - 45°C)

Developing Time: 3 to 3.5 minutes for a 4.0-mil film (spray developer operating at 15 to 20 psi and 104°F [40°C)

The developing temperature, and hence the developing time, may be optimized to suit individual requirements. Good (20 to 40 psi) spray pressure is critical.

Semi-aqueous Developing -

The recommended semi-aqueous developing solution for LAMINAR DM Dry Film Solder Mask is Dynachem KB-1 Developer. KB-1 Developer is mixed as follows (26 gallons [98.4 litres]):

1 Water - 24 gallons (91 litres).
2.Add KB-1 Part A - 1 gallon (3.75 litres).
3.Add KB-1 Part B - 1 gallon (3.75 litres).
4.Heat to 90'F (32°C).
5.Discard when pH falls below 10.0 or if developing time increases.
6.Typical developer loading is 5 square feet per gallon (0.12 square meters per litre) of actual developed area for 4.0-mil LAMINAR DM Dry Film Solder Mask.

Developing Instructions

1.Remove (peel) the protective polyester cover sheet from the solder mask.
2.Develop (20 to 40 psi) 3 to 3.5 minutes for a 4.0 ml film. The actual development time is a function of the spray pressure, temperature, developing chemistry, etc. While 3 to 3.5 minutes (the time solder mask is actually in the developing chamber) is typical, the correct development time should be established as follows:

   a.When complete removal of the film is seen one-third (33 - 50%) to one-half way through the developing chamber, and
   b.No solder mask residues can be seen in the small plated-through holes or at the base of the sidewall.

3.Thoroughly water rinse. A rinse water spray pressure of 15 psi minimum and rinse chamber (50%) length half as long as the developer chamber length is recommended.
4.Dry the panels (air knife or equivalent).
5.Developing temperatures should be optimized to fit the capabilities of the equipment, the developer used and the application requirements.
6.Dynachem's antifoam products should be added to the developer at the rate of 1 to 4 ml per gallon if excessive foaming in production is noticed. Additions should be made as required to reduce foaming as increased amounts of LAMINAR DM Dry Film Solder Mask is processed through the solution.
7.The developing machine should be rinsed out thoroughly with hot water once per week.

Cure

The recommended post cure for LAMINAR DM Dry Film SolderMaskconsists of:

1 .UV cure side A at 3-4 ft/min (1.0 - 1.3m/min) per 200 watt/in (80 watt/cm) mercury lamp. For example, a 3 lamp UV curing unit with 200 watt/in (80 watt/cm) lamps would be run at a conveyor speed of 9-12 ft/min. (3-4 meters/min.). This UV dosage is equivalent to 3-5 joules/cm^2 when measured with an International Light model #745 UV Radiometer using the #A-309 "Light Bug" or the model #390 Radiometer, also from International Light.
2.Allow boards to cool to room temperature.
3.Repeat Step 1 on side B.
4.Allow boards to cool to room temperature.
5.Thermal cure boards in a forced air oven for one hour at 300°F (149°C).

Curing Notes

1.For best solder mask performance, the UV cure cycle should be done before the thermal cure cycle.
2.For the thermal cure cycle, the oven must be allowed to reach 300°F (149°C) before the timing (1 hour) begins. Forced air ovens are notorious for having hot and cold zones Therefore, the usage of Dynachem Thermolabels, Set #4 (240-280°F, 116-138°C) and Set #5 (290-330°F, 143-166°C) is encouraged to ensure that all boards throughout the oven reach the proper temperature.

Soldering

Pre-Assembly Soldering - Hot Air Leveling

LAMINAR DM Dry Film Solder Mask coated boards with both copper and black or brown oxide-treated copper circuitry have been successfully processed through hot gas (air) solder leveling with good results. Under certain conditions, however, solder particle pick-up can be observed. Solder pick-up can be avoided by maintaining low to moderate (230 to 250°C) solder temperatures and slow withdrawal speeds (panel from solder).

As a guideline, the following conditions may be used:

Machine:	Gyrex 520.
Air Knives:	350 to 375°F (176 - 190°C).
Air Line Pressure:	30 psi.
Preheat Temperature:	160°F (71°C).
Preheat Temperature:	12 to 16 seconds.
Flux:	Gyrex Air-brite 2.
Solder Temperature:	440 to 460°F (227 to 238°C).
Solder Dwell Time:	5 to 9 seconds.

These parameters are guidelines only and should be optimized for a given process.
As noted before, careful copper surface preparation is also required to avoid solder mask breakdown (blisters and/or adhesion loss) on the copper.
The flux should also be fresh, and the solder bath free of dross.

Careful defluxing after the hot air leveling process is important. Follow the flux manufacturer's recommendations for thorough defluxing. As a final step, to ensure complete removal of flux residues and to produce an aesthetically appealing finish PC board, a spray rinse with a warm, mild alkaline solution is recommended. A 1 % sodium or potassium carbonate solution at 105°F (41°C) works well. Follow the alkaline rinse with a thorough cold water spray rinse and a warm air dry.

Assembly Soldering

LAMINAR DM Dry Film Solder Mask coated boards have been successfully assembled using commonly encountered wave soldering parameters. Problems that might be encountered and their recommended solutions are as follows:

Solder Pick-Up

This usually occurs when highly activated fluxes are employed. As noted before, UV post exposure after thermal baking minimizes the chance for solder pick-up to occur.

White Residues

White residues can arise on the solder mask surface after fluxing, soldering and subsequent defluxing. These residues can be ionic (tin or lead halides or rosin salts) or non-ionic (insoluble rosin derivatives).

White flux residues can occur on any (UV or thermal screen ink or dry film) solder mask surface.In the case of LAMINAR DM Dry Film Solder Mask, they are less likely to be related to improper cure (exposure, thermal post bake or UV post cure). Instead, they are often related to the solder parameters and the specific flux and defluxing solvents used.

Troubleshooting Guide

Possible causes of white residue on solder mask after wave soldering:

Soldering Parameter Related

Problem	Cause	Recommendation
overcurred flux resin	Preheat temperature too high for conveyor speed	Decrease preheat temperature
Flux Activator residues	Preheat temperature too high for conveyor speed	Decrease preheat temperature
Flux resin hardens with age	Delayed cleaning (defluxing)	Clean immediately after soldering

Flux/Defluxing solvent Related

Flux Type	Defluxing Solvent	Recommendation
Rosin	Trichlorotrifluoroethane or trichlorotrifluoroethane/alcohol azeotropes	Use a purified rosin or solvent soluble synthetic flux
Rosin	1,1,1-trichloroethane or 1,1,1-trichloroethane/alcohol	White residues not normally encontered
Water soluble	water	1. Use “soft” water 2. Add 1 to 30% detergent to water.

Since the number of possibilities, permutations of soldering conditions, fluxes and defluxing solvents is very large, we may not have investigated the particular set of circumstances you will encounter in some of your or your customer’s assembly plants. It is important that LAMINAR DM dry film solder Mask coated boards be evaluated in each soldering operation that is expected to be encountered. The user should verify this soldermask’s compatibility with the assembly soldering operation **prior to adopting this mask**. Your Shipley representative will be happy to assist you in this evaluation.

Typical Properties

Physical Properties - Unexposed Film

Property	Value	Test Method
Appearance	Transluscent, green photopolymer	Visual
Solids Content	100%	ASTM D-1 259

Physical Properties - Cured Film

Property	Value	Test Method
Appearance	Green, semigloss finish	Visual
Flammability Rating (solder at 550'F [288'CI for 20 seconds).		Underwriters Laboratories 94 Flame Class Test File #E68935
3.0 mil (75 micron coating thickness; FR-4 62 mil (1.57mm) laminate thickness	94V-0	
4.0 mil (100 micron) coating thickness; FR-4 62 mil (1.57mm) laminate thickness	94V-0	
Pencil Hardness 3.0 mil 2H-3H 4.0 mil 2H-3H		IPC-SM-840B Method 2.4.27.2 (ASTM D3363-74)
Adhesion		
Non Melting Metals	Pass (Class 3)I	PC-SM-804B Method 2.4.28
Melting Metals	Pass (Class 3)I	PC-SM-804B Method 2.4.28.1
Soldering/Desoldering	Pass	IPC-SM-804B Paragraph 4.8.9.2

Chemical Resistance Properties - Cured Film

Chemical	Value	Test Method
Isopropanol	Pass	IPC-SM-840B
1,1,1 - Trichloroethane	Pass	Paragraph 4.8.6.1
Methyl Ethyl Ketone	Pass	(2 min. immersion)
1,1,1 - Trichloroethane	Pass	
(boiling vapor)		
96% 1,1,1 -		
Trichloroethane	Pass	
4% Ethanol (boiling vapor)		
TSP at PH 13.0	Pass	
2% Loncotergel #449	Pass	
at 140'F (60'C)		
Fluxes		
Alpha 61 1 A	Pass	IPC-SM-840B
Alpha 850-33	Pass	Paragraph 4.8.6.2
Lonco 7733-TA	Pass	
Solderability/Resistance	Pass	IPC-SM-840B
to solder		Paragraph 4.8.9.1

Electrical Properties - Cured Film

Property	Thickness in (mils)	Value	Test Method
Dielectric Strength	3.0	1366 volts/mil	IPC-SM-840B
	4.0	1600 volts/mil	Method 2.5.6.1
Insulation Resistance			IPC-SM-840B
Initial	3.0	2 x 10^{14}	Paragraph 4.8.1 1
	4.0	1 X 1014	ohms
After flux/solder/ deflux	3.0	1 X 1014 ohms	
	4.0	7 x 101@ ohms	
Moisture and Insulation Resistance (7 days 25-65'C cycling, 90% RH minimum)	3.0	5 x 10- ohms	IPC-SM-840B
	4.0	5 x 10- ohms	Method 2.6.3.1
Electromigration Resistance (7 days at 85'C, 90% RH with 10 VDC bias)	3.0	Pass	IPC-SM-840B
	4.0	Pass	Method 2.6.14
Hydrolytic Stability (28 days at 99'C, 98% RH maximum)	3.0	Pass	IPC-SM-840B
	4.0	Pass	Method 2.6.1

Storage

LAMINAR DM Dry Film Solder Mask should be stored in a cool, dry area; 70°F (20°C) or below is recommended. Under proper storage conditions, shelf life is six months from date of manufacture.

LAMINAR DM Dry Film Solder Mask is sensitive to sunlight and indirect white light. Gold or yellow fluorescent "safe lights" may be required in the immediate work area.

Consult the Current Material Safety Data Sheet for further storage information.

Packaging

LAMINAR DM Dry Film Solder Mask is manufactured in thicknesses of 3.0 and 4.0 mils (75 and 100 microns). LAMINAR DM Dry Film Solder Mask is available in widths ranging from 6 to 25 inches (1 6.2 to 63.5 cm) in increments of 1/4 inch (0.6 cm). Standard lengths are 100 and 250 feet (30.5 and 76.2 meters) on 3 or 6-inch (7.6 or 15.2 cm) diameter cores.

AUXILIARY PRODUCTS AVAILABLE

Developer Concentrates, Antifoams, Stripper Concentrates, Acid Soak Cleaners, Graphic Products

Developer Disposal

Waste material disposal will vary with local requirements. It is suggested that inquiries be made to determine what they are. A typical disposal operation would be:

1. Transfer spent solution to a treatment tank.
2. Slowly add dilute sulfuric acid (25% by volume) to lower the pH to 5.0
3. Allow the polymer to precipitate out at this pH, then filter through an acid-resistant coarse filter.
4. Adjust the pH with caustic to meet local regulations before discarding.
5. The filtered polymer sludge may be land filled or incinerated, depending upon existing applicable waste disposal regulations.

Safety And Handling

Please read and understand this product's current Material Safety Data sheet before use.

It is the customer's responsibility to ensure that disposal of this product complies with national and local guidelines.

LAMINAR Dry Film Photopolymers should be applied in a well ventilated area. Commercial laminating and post-curing equipment may cause vapours to be generated from the dry film, and these vapours should be removed by conventional exhaust techniques.

Wash thoroughly after handling. Contact of the unexposed resists with the skin may cause irritation and should be avoided. Sensitization may occur in some individuals. If contact occurs, wash thoroughly with soap and water. If -irritation occurs and persists, consult a physician.

Avoid reuse of or contact with the dry film release sheets and cover sheets, since they may retain small amounts of unpolymerized photoresist components.

During cleaning, developing, stripping, etching, soldering, and plating operations, follow the safety precautions pertaining to the particular solution(s) or material(s) being used.

Flush empty containers thoroughly with water before discarding.

BEFORE USING THIS PRODUCT, REFER TO THE CURRENT MATERIAL SAFETY DATA SHEET FOR DETAILED SAFETY, HANDLING AND STORAGE INFORMATION.

For Industrial Use Only

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ISO 9002
Q 05293

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