

Secondary Imaging

Dynamask® 5000 Series
Dry Film Soldermask

Introduction:

Product Description:

Dynamask[®] 5000 Series Dry Film Solder Mask (DFSM) is an aqueous processible, dry film photopolymer solder mask, utilizing epoxy chemistry materials well known for their electrical insulation, chemical resistance and dimensional stability properties. Dynamask 5000 key performance properties include:

- Compatible with No Clean and aqueous based fluxes and Solder Pastes.
- Wide process latitude.
- Scratch resistant flexible film which improves via hole tenting integrity.
- Excellent resolution capability.
- Low tendency for light bleed.
- Utilizes epoxy based chemistry for excellent physical, chemical mechanical and electrical resistance properties.
- Meets or exceeds the requirements of IPC SM840C Class T & H, Mil P55110D and Bellcore requirements.

Dynamask 5000 series film is a transparent, high gloss forest green material which is supplied in thicknesses of 75 microns (3mils) and 100 microns (4 mils) the film is supplied in several widths and a roll length of 100 mtrs.

Like most other dry film products the photopolymer is sandwiched between a 25 micron (1.0mil) polyester support sheet and a 25 micron (1mil) polyethylene release sheet..

Application:

Dynamask 5000 series DFSM is recommended for use on rigid printed wiring boards, epoxy or polyimide laminates, and performs well on a variety of metallic circuitries such as, copper, tin lead, bright acid tin, nickel and gold.

Dynamask 5000 is compatible with most soldering operations, such as, Hot Air Solder Levelling, Wave Soldering, Vapour phase and Infra Red soldering. The products will withstand most solvent and aqueous defluxing media.

Because of Dynamask 5000 series high resolution characteristics, straight sidewall via holes tenting, chemical and thermal resistance properties, the product is ideally suited for use on high density surface mount technology (SMT) printed wiring board designs.

Dynamask 5000 series DFSM is designed for use on rigid printed wiring boards and is not recommended for use on flexible circuits.

General Processing Steps:

The processing of Dynamask 5000 consists of the following steps:

- 1) PWB Surface preparation.
- 2) Vacuum Lamination.
- 3) Exposure.
- 4) Development
- 5) Final Cure.

Environmental Requirements:

Lighting:	Yellow Light.
Room Temperature:	20° - 22°C
Relative Humidity:	40 - 60 %

Surface Preparation:

To ensure the optimum adhesion of Dynamask 5000 the surface to be laminated should be free from dust particles, grease, oxides and other forms of surface contamination. Suitable cleaning methods include the following:

A. Copper :

A clean dry copper surface with the correct surface topography is very important for good solder mask performance in both Hot Air Solder Levelling and in assembly soldering processes. There are several methods of cleaning copper surfaces :

Brush Pumice.
Wet Brushing.
Jet Pumice.

Chemical cleaning can also be used however more process control is required. Where chemical cleaning is the preferred option, please discuss with your local Shipley representative.

A recommended process proven to be effective is :

- 1) Spray rinse with a 5% solution of hydrochloric acid.
- 2) Rinse in mains water plus a DI water rinse.
- 3) Brush Pumice (grade 3F)
- 4) Rinse in mains water plus a DI water rinse
- 5) Air knife and forced warm air blow dry.

It is important that the cleaned boards be free from any oxidation and moisture. Complete drying can be accomplished by drying the boards in a batch oven for 30 minutes at 72 °- 82°C . This is particularly important where there is a requirement for reliable via hole tenting.

The acceptability of the cleaned copper surface may be checked as follows:

- 1) Cleanliness / Wettability. A clean surface should hold an unbroken film of water for at least 30 seconds.
- 2) Surface topography measurement should show 18 to 24 peaks / 100 microns with a score depth of 2.0 to 4.0 microns.

B. Fused Tin Lead.

As with other surface finishes, boards should be clean, dry and free from residues of fusing fluids. A cleaning process proven to be effective is :

1. Spray Rinse with a hot alkaline detergent at a temperature of 50° to 54° C
2. Spray rinse with warm mains water 50° to 54° C .
3. Rinse in DI water
4. Air knife and or forced air dry.
5. Batch oven dry at 110° to 129°C for 30 minutes

Drying.

As stated elsewhere drying boards after surface preparation is important. Applying the Dynamask 5000 DFMS to a board that has been improperly dried can result in both general adhesion loss and also hole tenting failure.

Lamination.

Dynamask 5000 series DFMS is recommended to be applied to the printed wiring board by :

Pre Tack Lamination using a Model 360 DFMS laminator or a hand lay up table. This is followed by :

Vacuum Lamination equipment, such as the Shipley Vacuum Laminator models 724 / 725.

Hot roll lamination is NOT recommended because of the potential conformation / air entrapment issues.

A. Solder Mask Thickness Selection.

Dynamask 5000 Series DFMS is available in thicknesses of 75 micron (3ml) and 100 micron (4ml)

The choice of solder mask thickness will depend on the pwb design geometries and height of the circuitry. As a general guideline the film thickness selected will encapsulate the same conductor thickness. However it is possible to laminate circuit heights up to 100 microns high with a 75 micron thick film. And circuit heights of 100 up to 125 microns the 100 micron thick film.

B. Recommended Lamination Conditions.

1. Apply the Dynamask 5000 Series DFMS solder mask to both sides of the pwb using a suitable pre laminator .(Shipley # model 360 DFMS) or by hand lay up. (At this stage of the process not heat or pressure is applied to the laminated pwb)
2. Set up the Shipley Vacuum Laminator according to the following parameters.

Install Vacuum Applicator Bleed In Kit.

Set the Slap Down Cycle for 6 seconds (range 4 to 12 seconds)

3. Set Top Platten Temperature to 55° to 65°C

Set Bottom Platten Temperature to 55° to 65°C

4. Set Cycle time to 60 seconds (range 40 to 90 seconds)

5. Vacuum should be 1.0 mbar minimum

6 Free space in the vacuum chamber 1.0 to 2.0 mm

Note re free space / shim height in the vacuum chamber.

To effectively vacuum laminate it is necessary to adjust the the shim height of the bottom platten inserts for different panel thicknesses. This is measured by placing the panel on the blanket in the bottom platten and increasing or decreasing the amount of shims to achieve the free space of 1.0 to 2.0 mm.

Free Space is the distance between the top of the panel and the top of the lower vacuum chamber.

The objective in lamination is to achieve a Board Surface Temperature of 49° to 60°C. BST measurement is measured by the use of temeperature tapes.

Following the lamination process boards should be racked vertically and allowed to cool to room ambient temperature before going for exposure.

Exposure.

All Dynamask 5000 series DFMS films are negative working photopolymers which can be exposed utilizing conventional non collimated UV exposure sources.

Allow the pwb,s to cool down to room ambient temperature after vacuum lamination before exposure. This is usually accomplished in 15 to 30 minutes. It is preferable to expose the Dynamask 5000 resist within two hours of lamination.

The exposure time for the proper polymerisation of the Dynamask 5000 is a function of the type and the intensity of the light source. It must be determined empirically for each exposure unit used.

The films are designed to react in the spectral sensitivity range of 350nm to 450nm wavelength. Acceptable exposure levels can be achieved by using time / energy parameters that give a clear metal step of 12 to 15 on a Stouffer 21 Step Sensitivity guide. The energy required to achieve the correct exposure will be in the range of 100 to 500 mj cm².

Note:

The amount of exposure energy the film receives will impact, resolution and adhesion, it can also impact the level of ionic contamination on the film after develop / cure.

Prior to developing a hold time of 15 to 30 minutes is recommended. Panels should be developed within two hours of exposure, but may be held for up to 72 hrs prior to developing.

Developing.

Unexposed (unpolimerised) Dynamask 5000 Series DFMS can be easily developed using a mild alkaline solution in a totally aqueous, conveyorised spray developing unit.

Development is followed by a thorough mains water rinsing, DI water rinsing and finally a turbine dry.

Shiplely recommend the use of their proprietary developing products REsolve 211 and REsolve 212R for developing Dynamask 5000 DFMS products.

Typical developing parameters:

1. Developing Solution - 1% sodium or potassium carbonate (monohydrate) solution at a temperature of 27° to 35°C.
2. Spray pressure 1.7 to 2.1 bar. (25 to 30 psi)
3. Breakpoint 40 to 50% of the distance into the developing chamber.
4. Spray Rinse
5. Rinse Temperature 15 to 35°C
6. Spray Pressure 1.7 to 2.1 bar. (25 to 30 psi)
7. Air knife and /or forced air blow dry

Note:

The length of the rinse chamber should be at least 50% of the developing chamber length. For every meter of developing we advise 0.5 meters of rinse.

Adequate rinsing after developing is required to remove all of the developing media and remove ionic contaminants which can reduce post HASL ionic cleanliness values. In order to meet stringent ionic cleanliness levels we advise the use of a cascading deionised water rinse after mains water rinsing. This is especially important where the mains water is hard.

Boards should be thoroughly dried after the developing process.
Excessive moisture in the film prior to the UV cure can result in the resist blistering on metallic surfaces.

Antifoam.

Depending upon the quality of water, developer chemistry quality and the amount of dry film loading, it may be necessary to utilize an antifoam in the developing solution. Shipley recommends for this purpose the use of Foamclear AF 2750. The amount used should be in the range of 0.13 to 0.26 mls /ltr.

Antifoam should be added at the time of developer solution make up. For automatic feed and bleed systems, add the anti foam directly to the developer sump at the predetermined rate.

Note:

Do not use Anti Foams containing miscible solvents as they will attack the resist.

Final Cure.

Optimal physical, chemical, electrical environmental and end user assembly soldering performance properties of Dynamask 5000 Series DFMS are obtained only after the final cure process.

The final cure (cross linking process) is a two step process involving both high intensity Ultraviolet energy (UV) (The recommended lamp type is 80watt /cm mercury vapour) This is followed by a thermal cure.

The curing process is as follows:

1. UV Cure at 3 to 4 J/cm² (Single or double sided UV cure machine with 2 or 3 lamps)
2. Thermal cure in either a batch or conveyerised tunnel oven for 60 minutes at a temperature of 150° C (Range 145°C to 154°C.)

Note.

It is recommended that the UV cure process be carried out before the thermal cure process.

Under curing can impact the performance of Dynamask 5000 series DFMS adversely in both Hot Air Solder Levelling and in assembly soldering processes.

Over curing Dynamask 5000 series, at temperatures greater than 154° C can result in loss of resist adhesion to copper surfaces, especially on ground plane areas.

Shipley recommends tight process control on the curing process, time and temperature.

Mechanical, Electrical and Chemical Data for the Cured Dynamask 5000 Solder Mask.**Physical Properties - Unexposed Film**

Property	Test Method	Requirement	Value
Appearance	Visual	None	Transparent high gloss green photopolymer
Solids Content	ASTM D- 1259	None	100%

Material Properties – Cured Film.

Property	Test Method	Requirement	Value
Appearance	Visual	None	Dark Green high Gloss Finish
Visual	IPC SM840 B 4.8.1	A maximum of 1 imperfection in in ² which does not bridge more than one conductor. No encroachment of foreign material (class 3)	Pass. Less than one imperfection /in ² both before and after soldering..
Dimensional	IPC SM 840 B 4.8.2. TM 2.1.1	0.7mil minimum	Pass. Dependant upon Dynamask Thickness and circuit height.
Non Nutrient	IPC SM 840B 4.8.1.1 TM 2.6.1	No support of, contribution to or degradation by biological growth.	Pass
Curing.	IPC SM 840 B 4.8.5	Meet requirements of IPC SM 840 B 3.6.1,3.7.1, 3.7.2, and 3.7.3	Pass. (See Chemical and Soldering properties.

Physical Properties – Cured Film

Property	Test Method	Requirement	Value
Adhesion	IPC SM 840B	Class3	Pass. (Before and after soldering)
	4.8.4.1 TM 2.4.28		
Bare Copper		0% Removed	0%
Bare Laminate		0% Removed	0%
Melting Metals		Max 10% Removed	<4%
Machinability	IPC SM 840B 4.8.1.2	No crack or tears due to normal machining	Pass
Abrasive Resistance	IPC SM840B TM 2.4.27.1	50 cycles min (class 3)	>50cycles
Pencil Hardness	IPC SM 840B TM 2.4.27.2	F (min)	4 H

Chemical Resistance Properties. – Cured Film

Property	Test Method	Requirement	Value
Resistance to Solvents.	IPC SM 840B 4.8.6	No surface roughness, tackiness, blistering or colour change	
Isopropanol (boiling vapour)			Pass
1,1,1, trichloroethane (boiling vapour)			Pass
96% 1,1,1, trichloroethane ,4% isopropanol (boiling vapour)		Pass	
TSP solution (pH = 13.0)		Pass	
3% Alpha 2210 at 60°C		Pass	
10% Alkaline detergent. (40% alkanolamine,20% butoxyethanol, 20% glycol etherand 20% water) at 60° C			
Fluxes	IPC SM840B 4.8.6	No surface roughness, tackiness, blistering or colour change	
Air – Brite 1			Pass
Argus 855			Pass
Ardrox			Pass
Kester 185			Pass
Alpha 850-33			Pass
Lonco 7733- TA			Pass
Hydrolytic Stability	IPC SM 840B 4.8.7. TM 2.6.11	No irreversible change of state	Pass (>28days)
Flammability Rating	Underwriters Laboratories 94 Flame Class Test	IPC SM 840B 4.8.8. UL 94 V number shall not be raised.	
2.3 mil thickness 0.025in FR4 laminate thickness.		94. V-O	94V-0
2.3 mil thickness 0.062 in FR-4 laminate thickness		94 V- 0	94 V.0

Soldering Properties - Cured Film UL File No E68935

Property	Test Method	Requirement	Value
Solderability	IPC SM840B 4.8.9.1 inspected to IPC 804.	The solderability of the board shall not be diminished	Pass
Solder Resistance	IPC SM 840B 4.8.9.2	Solder shall not adhere to the solder mask.	Pass (>10 sec)
Soldering / Desoldering	IPC SM840B 4.8.9.3	No separation from base laminate or conductors beyond the area of fused coating.	Pass (No separation under 7x magnification.)

Electrical Properties - Cured Film

Property	Test Method	Requirement	Value
Dielectric Strength	IPC SM840B 4.8.10.1 TM 2.5.6.1	500VDC Peak / mil min.	75micron (3mil) 1842volts/mil 100 micron (4 mil) 2976 volts /mil
Insulation Resistance	IPC SM840B 4.8.10.2 TM 2.6.3.1.	5 X 10 ⁸ ohms. Class 3 minimum	>1 x10 ¹² ohms
Dielectric Constant Dissipation Factor			3.56 0.038

Environmental Properties – Cured Film.

Property	Test Method	Requirement	Value
Moisture Insulation Resistance	IPC SM840B 4.8.10.3 TM	5x10 ⁸ ohms Class 3 minimum	75 micron (3mil) 2.6 x 10 ⁹ ohms 100 micron (4mil) 2.5 x 10 ⁹ ohms
Electromigration	IPC SM840B 4.8.10.4 TM 2.6.14	Non Allowed (Class 3)	
Thermal Shock	IPC SM840B 2.6.7.1 TM4.8.11	No blistering, crazing or delamination after 100 cycles.	Pass (>100 cycles)

Handling Precautions.

Before using Dynamask 5000 Series DFMS Products consult the Material Safety Data Sheet, for details on product hazards recommended handling precautions and product storage.

Storage.

Dynamask 5000 Series DFMS products should be stored in a dry (30 to 70% Relative Humidity) cool (18° to 20° environment. Under proper storage conditions, the shelf life of the product is six months from the date of shipment.

Dynamask 5000 Series products are sensitive to sunlight and indirect white light. Gold or Yellow fluorescent "safe lights" are required in the immediate work area. Consult the Material Safety Data Sheet for further storage information.

For Industrial Use Only

This information is based on our experience and is, to the best of our knowledge, true and accurate. However, since the conditions for use and handling are beyond our control, we make no guarantee or warranty, express or implied, regarding the information, the use, handling, storage or possession of the products, or the application of any process described herein or the results sought to be obtained. Nothing herein shall be construed as a recommendation to use any product in violation of any patent rights. All sales are subject to our standard Terms and Conditions of Sale.

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