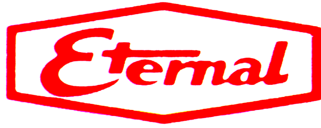


TECHNICAL DATA SHEET

DYNAMASK® 5000 SERIES DRY FILM SOLDER MASK

DESCRIPTION – Revised 5/16/2018

DYNAMASK® 5000 SERIES DRY FILM SOLDER MASK is an aqueous processable dry film photopolymer solder mask utilising epoxy chemistry materials well known for their electrical insulation, chemical resistance and dimensional stability properties.

PHYSICAL CHARACTERISTICS

DYNAMASK® 5000 series DFSM is a solvent-free, transparent, high gloss forest green material supplied in roll form. The photopolymer layer is coated as a defect free film and is available in 1.6mil (40µm), 3.0mil (75µm) and 4.0mil (100µm) thicknesses. Product designations are D5016, D5030 and D5040 respectively.

PRODUCT CHARACTERISTICS

- Excellent resolution capability
- Low light bleed characteristics
- Scratch resistant flexible film which improves via hole tenting integrity
- Wide process latitude
- Compatible with No clean and aqueous based fluxes and solder pastes

In addition, **DYNAMASK® 5000** series DFSM meets or exceeds requirements of IPC-SM-840E as indicated in the addendum.

DYNAMASK® 5000 series DFSM is recommended for use on rigid printed circuit boards, epoxy or polyimide laminates and performs well on a variety of metallic surfaces such as copper, tin-lead, nickel and gold and also on silicon wafer substrates. The product is not recommended for use on flexible circuits. The product is compatible with most soldering operations such as Hot air solder levelling, wave soldering, vapour phase and infra red soldering. The product will withstand most solvent and aqueous defluxing media.

Processing

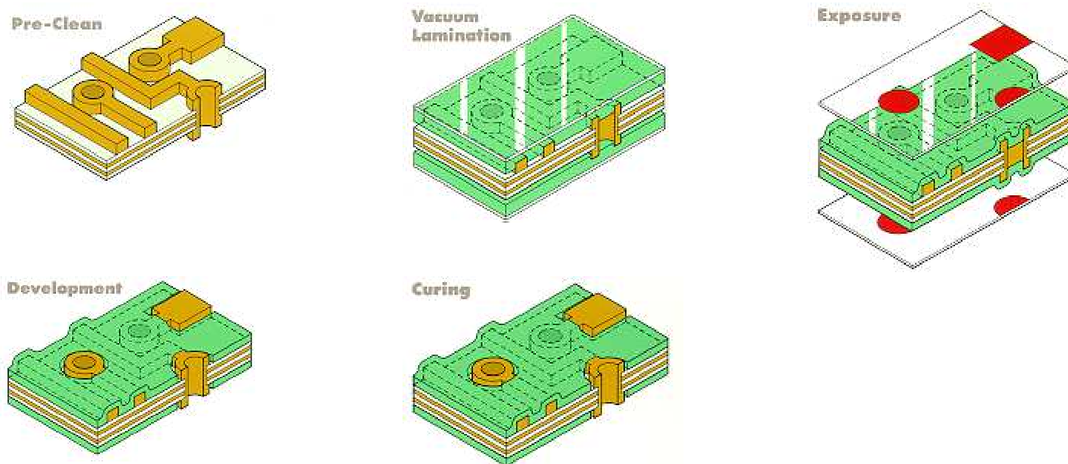
Processing environment

DYNAMASK® 5000 series DFSM is a negative working photo-polymer and is sensitive to ultra violet light, excessive temperature and relative humidity. Lamination and exposure steps should be conducted in a controlled yellow room environment under the following guidelines:

- Yellow room lighting
- Temperature controlled at 20 to 22°C (68 to 72°F)
- Relative humidity controlled at 40 to 60%

Process sequence:

DYNAMASK® 5000 series DFSM processing sequence is shown schematically below:



Surface preparation

Pre-cleaning of the circuit board is essential to the adhesion of the solder resist and the electrical performance of the solder resist and the electrical performance of the printed circuit board. Any moisture and / or organic contaminants trapped by the solder resist during lamination may cause solder mask delamination, blistering and / or adhesion loss during subsequent soldering operations or during extended use.

When cleaning copper circuitry which has been produced using a metallic etch process, it is important to remove all inter-metallic compounds, oxides, organic and ionic contaminants. An abrasive scrub is necessary to provide a rough surface for the resist to adhere. The presence of contaminants or the elimination of the abrasive scrub step may cause adhesion loss. Good drying is essential to prevent the solder mask blistering during hot air solder levelling.

One method which has proven successful for pre-cleaning copper circuitry is as follows:

1. Conveyorised acid spray rinse (5% H_2SO_4)
2. Water spray rinse
3. Pumice (3F / 4F) or impregnated brush (320grit) scrub

4. High pressure water spray rinse
5. DI water spray rinse
6. Turbine dry
7. Bake dry for 30-minutes at 71 to 82°C (160 to 180°F)
8. Maximum hold time from pre-clean to lamination 4 hours. Ideally substrates should go directly to the laminating area to avoid the risk of contamination.

When cleaning fused tin-lead circuitry and other melting metals for which abrasive scrubbing is not permitted, it is important to remove all oxides, organic contaminants and moisture prior to solder resist application.

One method which has proven successful for pre-cleaning such circuitry is as follows:

1. Conveyorised saponifying spray cleaner
2. Water spray rinse
3. DI water spray rinse
4. Turbine dry
5. Bake dry for 20 to 30-minutes at 110 to 130°C (230 to 265°F)
6. Maximum hold time from pre-clean to lamination 4 hours. Ideally panels should go directly to the laminating area to avoid the risk of contamination.

Chemical cleaning can also be used for surface preparation. Where chemical cleaning is the preferred option please consult your local Technical representative for more detailed information on associated products and processes. As stated drying substrates after surface preparation is important. Applying **DYNAMASK® 5000** series DFSM to a board that has been improperly dried can result in both general adhesion loss and also hole tenting failure.

DYNAMASK® 5000 series DFSM is available in thicknesses of 1.6mil (40µm), 3.0mil (75µm) and 4.0mil (100µm). The choice of solder mask thickness will depend on the PCB design geometries and height of the circuitry. As a general guideline the film thickness will encapsulate the same height conductor thickness. However it is possible to laminate circuit heights upto 65µm high with a 40µm thick resist. Likewise circuit heights of 100µm can be encapsulated with a 75µm resist and upto 125µm with the 100µm thick film.

VACUUM LAMINATION

DYNAMASK® 5000 series DFSM is best applied to the printed circuit board utilizing vacuum lamination equipment. Hot roll lamination is not recommended because of potential conformation and / or entrapment issues. Lamination of **DYNAMASK® 5000** series DFSM should be performed in an environment that is free from dust and dirt. The condition and maintenance of the lamination equipment is very important to help achieve consistently high yields.

After **DYNAMASK® 5000** series DFSM film is pre-tacked onto the substrate, it is placed in a vacuum applicator. During vacuum lamination, a hard vacuum is drawn within the lamination chamber assuring complete air removal between the circuit traces. Concurrently both the solder mask and the substrate are heated to laminating temperature. Once the vacuum cycle is complete, the upper platen blanket “slaps down” forming the initial physical bond between the solder mask and ensuring conformance of the solder mask to the circuitry.

Vacuum Lamination	
Cycle time	60-seconds (40 to 90-seconds)
Slap down time	6-seconds (4.0 to 12.0-seconds)
Platen temperature	55 to 65°C (130 to 150°F)
Panel temperature	49 to 60°C (120 to 140°F)
Vacuum	1.0mbars minimum
Free space	1.00 to 2.00mm (0.04 to 0.08 inches)

The **DYNAMASK® 5000** series DFSM coating after polyester removal is soft and susceptible to damage. For this reason, substrates should be racked individually to prevent damage.

EXPOSURE

DYNAMASK® 5000 series DFSM can be processed on a conventional non collimated light source. Allow substrates to cool to ambient temperature before exposure. It is preferable to expose substrates within two hours of lamination. Exposure time for proper polymerisation is a function of the type and intensity of the light source. The product is deigned to react in the spectral range of 350 to 450nm wavelength. Acceptable exposure levels can be achieved by using time and energy parameters that result in Clear metal step 09 to 11 when using a Stouffer™ 21 step sensitivity guide. The energy requirement is normally in the range of 150 mj/cm^2.

Development

DYNAMASK® 5000 series DFSM develops in a totally aqueous solution of sodium or potassium carbonate. Development is followed by thorough water rinsing, DI water rinsing and turbine dry in order to meet stringent ionic cleanliness requirements.

Development	
Equipment	Horizontal or vertical
Chemistry	1.0% Na_2 or K_2CO_3
Temperature	27 to 35°C (80 to 95°F)
Breakpoint	40 to 50%
Spray pressure	25 to 30psi
Rinse chamber length	Minimum of 50% of developing chamber
Spray pressure	25 to 30psi
Rinse temperature	15 to 35°C (59 to 95°F)
Turbine dry	

The operating temperature of the working solution is extremely important to the development of the resist. Exceeding the recommended temperature range can cause attack of the resist. Operating at a lower temperature can result in attack of the resist due to excessive dwell time in the developing chamber. The breakpoint should be maintained within the recommended range of the developing chamber length.

DYNAMASK® 5000 series DFSM may require the use of a de-foamer. This will depend on several factors including water quality, developer chemistry quality, dry film photo resist loading and equipment design. If antifoam additions are required, AF2750 has been tested and shown to be acceptable and compatible with **DYNAMASK® 5000** series DFSM. Other anti-foams may be acceptable but these should be fully evaluated prior to use.

Anti-foam should be added according to the antifoam data sheet. Antifoam should be continuously added to the developer sump by means of a feed pump. Do not use antifoam products containing water miscible solvents as they will attack the dry film photo resist. Some petroleum based antifoams are also known to attack dry film photo resist and should be avoided.

CURING

Optimum physical, chemical, electrical, environmental and soldering performance properties of **DYNAMASK® 5000** series DFSM are obtained only after final curing. Final curing (polymerisation) is a two step process involving both UV and thermal cross-linking, utilising conventional UV curing units and convection air ovens.

UV Curing	
Speed	2.40 to 3.65m/min (8.0 to 12.0ft/min)
Energy	3.0 to 4.0J/cm2
Panel temperature	121°C maximum (250°F)
UV Cure side A at the above conditions	
Allow panels to cool completely to room temperature	
UV Cure side B at the above conditions	
UV cure process should be carried out before thermal cure process	
Thermal Curing	
Equipment	Forced air oven
Time	60 minutes at temperature
Temperature	145 to 155°C (293 to 310°F)
Allow oven to reach temperature before the one hour timing starts	
Curing at temperatures above 155°C can result in adhesion loss especially on ground plane areas	

STORAGE

DYNAMASK® 5000 series DFSM should be stored in a limited access area between 5 and 20°C (41 and 68°F) and 50 ± 10% relative humidity. For optimum performance, store in an area not exceeding 15°C (60°F). **DYNAMASK® 5000** series DFSM is sensitive to sunlight and indirect white light. Gold or yellow safelights are required in the immediate work area.

Safety and Handling

BEFORE USING DYNAMASK® 5000 SERIES DFSM, PLEASE REFER TO THE CURRENT SAFETY DATA SHEET (SDS) FOR DETAILED SAFETY, HANDLING AND STORAGE INFORMATION.

DYNAMASK® 5000 series DFSM should be applied in a well ventilated area. Commercial lamination equipment may cause vapours to be generated from the dry film, and these should be removed by conventional exhaust techniques. It is the customer's responsibility to ensure that disposal of this and other ancillary products comply with local, state and national federal guidelines.

Wash thoroughly after handling any dry film resist. Contact of the unexposed resist with the skin may cause irritation and should be avoided. Sensitisation 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 as they may retain small amounts of unpolymerised photo resist components. During cleaning, developing, stripping and etching operations follow the safety precautions pertaining to the particular solution(s) being used.

LIMITED WARRANTY. Based on our experience, we believe that the above information is accurate, but we offer no guarantee as to the use or application of our products or of this information. We warrant our products to be free from defects in material and workmanship; but because their use is beyond our control, we accept no responsibility or liability for damages, whether direct, indirect or consequential, resulting from failure in performance. In cases where our products are found to be defective in material and workmanship, our liability is limited to the purchase price of the products found to be defective. THIS WARRANTY IS TO THE EXCLUSION OF ALL OTHER WARRANTIES OR GUARANTEES, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, DESCRIPTION, PRODUCTIVENESS OR ANY OTHER MATTER. None of the above information may be construed as a recommendation that our products be used in violation of any patent rights. We accept your orders at our shipping points only on the basis of the above understanding which our employees have no authority to vary.

DYNAMASK® is a registered trademark of Eternal Technology Corporation, Richmond, VA2007

Addendum

Mechanical, Electrical and Chemical Data for cured **DYNAMASK®** 5000 Series Dry Film Soldermask. Compliance with IPC Soldermask Specification IPC-SM-840(E) as indicated below. Testing is performed under generic conditions as specified and as understood by the manufacturer to generally represent conditions of production manufacture. This does not constitute a guarantee of performance in a specific application. Specific applications should be qualified by the fabricator or as agreed to by fabricator and end user (AABUS) as denoted in IPC SM-840E, including paragraphs 1.2, 3.2.2.1, 3.2.5.1 and 3.2.5.2.

Material properties – Cured film

Property	**Test Method**	**Requirement**	**Value**
Appearance	Visual	None	Dark green High gloss finish
Non-Nutrient (3.2.6)	IPC TM 650 2.6,1	No support of, contribution to or degradation by biological growth	No fungus growth or corrosion.
Visual Requirements (3.3.1)	IPC SM840E 3.3	Uniform in appearance and free of foreign matter, cracks, inclusions, peeling and roughness that would interfere with assembly or operation of the PCB.	Uniform. No evidence of foreign matter, contamination, cracks, peeling or roughness.
Cure (3.2.5.1)	IPC SM-840E 3.5 – 3.9	Meet requirement of IPC SM840E 3.5 thru 3.9.	Pass See Physical, Electrical & Environmental properties below.

Physical properties – Cured film

Property	Test Method	Requirement	Value
Pencil hardness (3.5.1)	ASTM D-3363	F (minimum)	≧3H
Adhesion to Rigid Printed Boards (3.5.2.1)	IPC TM 650 2.4.28.1 IPC SM -840E 3.5.2.1	0% Delamination.	3.7.2: 0% Delamination 3.7.3: 0% Delamination (5016, 5030, 5040)
Adhesion of Layered or Double Coated Solder Mask (3.5.2.6)	IPC TM 650 2.4.28.1 IPC SM-840E 3.5.2.1	0% Delamination.	3.7.2: 0% Delamination 3.7.3: 0% Delamination Layer 1-DM5016/2-DM5030 Layer 1-DM5016/2-DM5040
Machinability (3.5.3)	IPC TM 650 2.4.7.1 IPC SM-840E 3.5.3	No Cracks, tears beyond base laminate when machined according to IPC TM 650 2.4.7.1	Pass

Electrical properties – Cured film

Property	Test Method	Requirement	Value
Dielectric Strength (3.8.1)	IPC TM 650 2.5.6.1	500VDC/0.001";min.; 500 VDC if<0.001"	1.8KV/mil: DM5030 2.9KV/mil: DM5040
Insulation Resistance (3.8.2)	IPC TM 650 2.6.3.1 SM-840E 3.2.5.1, 3.7.2, 3.7.3	Class T ≥ 500 M Ώ Class H ≥ 500 M Ώ	≥ 4670 x 10^4 M Ώ ≥ 1340 x 10^3 M Ώ DM5030; DM5040

Soldering properties – Cured film

Property	Test Method	Requirement	Value
Solderability (3.7.1)	IPC SM-840E 3.7.1	No soldermask residues impeding solderability	Pass
Solder Resistance 3.7.2/3.7.3	SM 840E 3.7.2; 3.7.3 IPC TM 650 2.6.27	No solder adherence or residues.	Reference for SM-840E: 3.5.2.1; 3.5.2.6; 3.8.2; 3.9.3
Simulation of Lead Free Reflow (3.7.3.1)	SM 840E 3.7.3 IPC TM 650 2.6.27	Solder shall not stick to the solder mask, no blistering	Pass

Environmental properties – Cured film

Property	Test Method	Requirement	Value
Moisture & Insulation Resistance (3.9.1)	IPC TM 650 2.6.3.1	Class T : ≧ 500 MΩ Class H: ≧ 500 MΩ	2100K MΩ 3700 MΩ DM5030; DM5040
Electrochemical Migration (3.9.2)	IPC TM 650 2.6.14	Class T: No visual observation; ≤ 10 Ω (one decade) Resistance drop. Class H: No Visual observation; > 2 MΩ Resistance.	Passed. Passed. 26 MΩ
Thermal Shock (3.9.3)	IPC TM 650 2.6.7.3 SM 840E 3.3	No blistering, crazing or delamination.	3.7.2: Passed. 3.7.3: Passed. DM5030; DM5040

Chemical resistance properties – Cured film (UL File No E251137)

Property	Test Method	Requirement	Value
Resistance to solvents and cleaning agent (3.6.1.1)	IPC TM 650 2.3.42	No surface roughness, swelling, tackiness, blistering and colour change Isopropanol (RT.) >2mins 75% isopropanol/25% deionized water(44~48℃) >15mins 10% Alkaline detergent (55~59℃) >2mins Monoethanolamine(55~59℃) >2mins Deionized water(58~62℃) >5mins D-Limonene(RT.) >2mins	 Pass Pass Pass Pass Pass pass
Hydrolytic stability (3.6.2)	IPC TM 650 2.6.11	No softening, chalking, blisters, cracks, tackiness, delamination, liquification.	Pass (> 28 days) No evidence of Cu corrosion.
Flammability (3.6.3)	UL-94	No increase in Base V number.	UL94 V-0: DM 5030 & 5040 on 0.062 FR-4 UL94 V-1 on DM 5030 & 5040 on 0.031 FR-4. UL-94 IR Inspection maintained. File #E251137