DuPont™ CooLam™

THERMAL SUBSTRATES FOR METAL CORE PRINTED CIRCUIT BOARDS (MCPCBS)

General Processing Guide for single layer, aluminum base

Introduction

DuPont™ CooLam™ thermal substrate is a composite of metal foil, and proprietary polyimide dielectric filled with thermally conductive inorganic fillers, bonded to a metal base.

This material system is ideal for today's demanding thermal applications requiring very low thermal impedance, very high operating temperature, excellent long term reliability, and electrical isolation. Typical applications include Light Emitting Diode (LED) lighting, LED backlights and LED packaging.

Standard DuPont™ CooLam™ LX thermal substrate constructions are filled polyimide dielectric thickness of 0.71 mil (17 µm) and 0.87 mil (22 µm) , foil weights of 1 and 2 oz./ft2 (35 µm and 70 µm) laminated to aluminum thicknesses of 0.040 in. and 0.063 in. (1.0 mm and 1.6 mm). Standard aluminum type is 5052 alloy. Other constructions, like 5005 alloy, may be available upon request depending on specific requirements for dielectric and thermal performance.

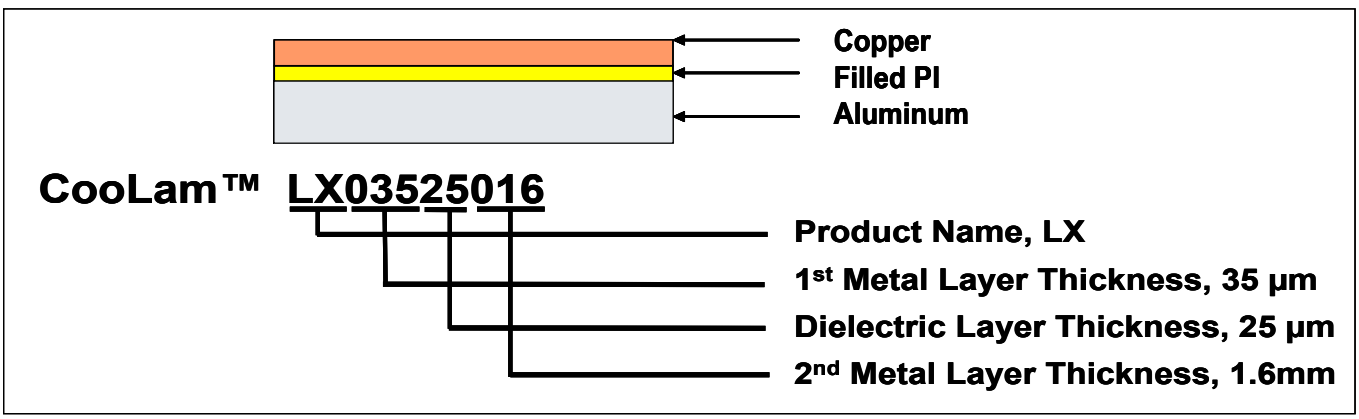
This document is a general guide for all the process steps that could be involved in the processing of CooLam™ thermally conductive, single layer materials with aluminum base heat sink. General guidelines are given; however, specific processes or pieces of equipment may require special considerations. We recommend you contact your DuPont Technical Representative for discussion of your specific process steps prior to using CooLam™ to ensure any special handling or processing requirements can be identified and addressed. This document refers to suppliers' processing guides such as DuPont™ Riston® Aqueous-Processable Photopolymer Films, General Processing Guide, for basic processing, storage, handling, and disposal information. Only processing considerations that are specific to the materials and construction of CooLam™ and are different from standard laminates are highlighted in this document.

This material passes the United States Commerce Control List Supplement 1 for Part 774 for international sales.

The data in this guide are based on conventional commercial processing equipment similar to that used in most printed circuit board fabrication facilities. However, since actual equipment and conditions vary from facility to facility, the information contained herein should be used only as a guide.

For more information on DuPont products for Semiconductor Packaging and Circuit Materials, visit our web site at: http://packaging-circuits@dupont.com.

DuPont™ CooLam™ thermal substrates nomenclature



Material Handling
DuPont™ CooLam™ thermal substrates with aluminum base metal can be handled like a typical, metal core laminate. Other DuPont™ CooLam constructions may require leader boards or frames.

Registration (Formation of Tooling Holes)
Tooling holes can be drilled or punched prior to imaging and etching or after etching ("post etch punch"). Tooling holes allow the registration of soldermask features to circuit features. In multilayer thermal substrates, tooling holes also allow the registration of several circuitized layers in the lamination press. Drilling parameters such as drill bit feed rate and speed (rpm) may have to be set differently from drilling standard FR-4 for optimal results. Panel stack height during drilling, i.e. the number of panels drilled in one operation, depends on the thickness of the panels. It is typically in the range of one to four.

Base Metal Protection
The base metal needs to be protected from etchant attack during the print & etch process. The developer chemistry does not attack copper or aluminum. If the copper surface cleaning process conditions do not involve chemistries corrosive to copper or aluminum, such as pumice scrubbing, then the base metal protection layer may be applied after development. If develop/etch/strip (DES) is in-line and/or the surface preparation chemistry attacks the base metal, then the protection layer needs to be applied before wet processing.

The protection layer may be a blank-exposed dry film photoresist, a screen printed etch resist, Plater's Tape, or a commercially available film that can be laminated and peeled off. Consult with your technical representative about the options. The protective films need to withstand the etch chemistry, be it acidic or alkaline. If a dry film photoresist is used, and the etch chemistry is alkaline etch, make sure that the selected dry film is designed for alkaline etch. If the stripper chemistry is corrosive to the base metal, then blank-exposed photoresist that will strip is not a protective layer. Most amine-based strippers are expected to be compatible with aluminum.

Regardless of the choice of protective film, the edge of the panel should be taped, e.g. with Plater's Tape, to avoid lateral attack of the etch chemistry at the film/metal interface.

Copper Surface Preparation
A properly prepared copper surface is essential for good dry film photoresist adhesion through the etching process. See DuPont™ Riston® Aqueous-Processable Photopolymer Films –General Processing Guide for details. Mechanical processes such as brush scrubbing, pumice or aluminum oxide scrubbing are options. In recent years, single-step chemical cleaners have become popular. These are acidic cleaners, most of which include a micro-etchant and some include an anti-tarnish. Follow the process guidelines provided by the supplier.

Note: this Process Guide document assumes that dry film photoresist is being used. Alternatives are liquid photoresists and screen printed (UV-curable) etch resists. Liquid photoresists may be applied by blank-screen printing, curtain coating, roller coating, or spray coating. Consult with the suppliers of such resists for processing details.

Photoresist Lamination
Riston® photopolymer photoresists can be laminated to CooLam™ with all modern manual or automatic sheet hot roll laminators. The panel surfaces may be cleaned with "tacky rollers', manual or automatic prior to lamination.

CooLam™ thermal substrates typically do not require transport aid during lamination. CooLam™ flex clads can also be laminated with Automatic or Cut Sheet Laminators (ASL or CSL).

In general, lamination parameters depend on the profile and thickness of the substrate material and the imaging requirements. Unlike glass-reinforced laminate, that has a weave component to the surface roughness caused by the glass knuckles, CooLam™ is smooth from a macroscopic viewpoint and does not have a weave component. Therefore, excessive temperature and pressure during lamination are not required for good resist adhesion.

Lamination speed and roll temperature may have to be adjusted to account for the larger thermal mass of metal core laminates. Use the "board exit temperature" guidelines in the Riston® General Processing Guide to check if the lamination parameters are right. The addition of a pre-heat unit is an option, but the best variable to adjust, if necessary, is the lamination speed. A higher hot roll temperature may lead to wrinkling. For additional details, check the Riston® General Processing Guide.

Exposure
CooLam™ panels are exposed like all other panels. The following general good exposure techniques are recommended:

- A clean environment
- Use of good quality phototools
- Excellent phototool/resist contact in the vacuum frame
- A light source suitable for the resist used
- An exposure intensity of 5 mW/cm2 or higher incident on the resist (through phototool)
- An exposure energy optimized for the processing equipment and conditions actually used

Development
Thermal substrates with aluminum base metal will not require special fixturing during development.

Breakpoint (Wash-off point)
The developer speed should be set based on the recommended breakpoint for each resist (see Riston® General Processing Guide). Breakpoint should be determined on unexposed panels that are of the

same size as production panels. For ease of checking the breakpoint on flex clads, laminate one or two rigid panels at the same time and with the same resist as used on the DuPont™ CooLam™ thermal substrates. Then, use the rigid panels to set the breakpoint. This will be easier and less costly.

Etching

Acid or Alkaline etching can be used with CooLam™. (Note: metal core laminates must have edges tapped prior to etching to avoid chemical reactions with the aluminum). For alkaline etching, dry film resists that are compatible with alkaline etching have to be selected.

Resist Stripping

CooLam™ panels can be stripped like any other exposed, developed, etched panel. For details, check the Riston® General Processing Guide.

Post Etch Punch

Post etch punching of CooLam™ should present no problem; however, check the operation of your post etch punch with CooLam™ prior to production to determine whether or not modifications to the post etch punch will be needed. Post-etch drilling is an alternative.

Layer Inspection

CooLam™ is compatible with automated optical inspection (AOI) equipment and procedures. As with other processes, careful handling will be needed. If standard alkaline stripping chemistry (NaOH or KOH) leaves the copper surface stained and leads to a high number of false AOI read outs, consider the use of amine based strippers.

Pre-Soldermask Copper Surface Preparation

Soldermask suppliers provide guidelines for copper surface preparation before soldermask application to assure good soldermask adhesion to copper. Brushing, pumice prushing or jetting, and micro-etch are typical surface preparation, similar to methods used before dry film lamination. The most common form of soldermask is the LPISM (liquid photoimageable soldermask). It can be applied by (vertical) blank screening, spray coating, or curtain coating. The selection of the soldermask is job-specific and may have been specified by the customer or designer. Most soldermasks are epoxy-based and the most common soldermasks are of green color. Some LED substrates may require a white soldermask to avoid a spectral shift of the reflected light of a white LED. After exposure and development, typically a solvent development, there is a curing step, in most cases a UV cure.

Surface Finishes for Soldering or Wire Bonding

The selection of the surface finish is typically specified by the customer/designer and the suppliers of the surface finish provide the chemistry and processing conditions, often also the equipment. The most common, and low cost surface finish has been hot air solder leveling (HASL), in recent years also as the lead-free version. The protective film for the base metal needs to be removed before HASL. Before subjecting panels to high temperature process steps like hot air solder leveling or hot oil reflow, bake panels at 125°C (250°F) for 2 to 6 hours. The time required will be determined by board thickness, number of layers and amount of copper on each layer.

An alternative is organic solderability preservative (OSP) which has a limited shelf life. Immersion tin and immersion silver are also increasingly being used. These processes work on the basis of an electrochemical exchange between the copper and surface finish metal whereby a small amount of copper goes in solution. Ni/Au is widely used as a wire bondable surface. The base metal needs to have a protective cover film during all of these operations.

Singulation of Parts

Three methods are in use to singulate parts out of a panel: routing, V-scoring, and punching. Routing is a versatile method, suitable for low volume quantities. Router bits have to be designed for metal removal. The aluminum of CooLam™ substrate is relatively soft due to the thermal history of laminate fabrication. This may affect the choice of routing parameters. Variables are spindle speed, chip load, table travel speed, vacuum, selection of cutting fluid, stack height and others.

V-scoring is a cost-effective method suitable for parts with square corners. V-groves are machined from both sides. Parts are singulated by breaking the remaining thin base material connections.

Punching is a cost effective method for high quantity lots. Punching conditions may have to be adjusted to avoid fracturing of the parts at the punch lines.

Hipot Testing

To assure proper insulation of the circuitry from the base metal, most end-users require hipot testing. The conditions for this test vary dependent on end-user requirements. Variables include test voltage, ramp-up speed, hold time at final test voltage, and acceptable leakage current. Proper fixturing is important to avoid false readings.

Packaging

Parts need to be properly packaged for shipment to avoid scratching, abrasion, and corrosion. Stacked parts are typically interleafed with slip sheets to avoid scratches and to avoid corrosion due to the galvanic cell effect when two dissimilar metals touch. The stack is then shrink wrapped (vacuum packed).

Storage

CooLam™ should be stored in its original shipping box until needed. Store CooLam™ between 5° and 30°C (40° to 85°F).

Reworking DuPont™ CooLam™ Panels

There may be a need to rework panels that have gone through dry film resist lamination, exposure, and development (e.g. because of lamination wrinkles, overexposure or underexposure, overdevelopment or underdevelopment). Such panels may have organic residues on the surface from the photoresist or antifoams. These panels should be sent through the prelamination surface preparation again to ensure a good surface for resist adhesion. If the panels are heavily oxidized a light microetch may also be required.

Safe Handling

Because DuPont™ CooLam™ thermal substrates are typically metal core laminates, sharp metal edges may cause a cutting injury if suitable gloves are not worn. We recommend the use of cut resistant or DuPont™ Kevlar® gloves when handling CooLam™. Obviously, the use of Kevlar® gloves would be impractical in the cleanroom during imaging. In this case, the use of cloth, cleanroom approved gloves is recommended along with emphasis on careful panel handling.

DuPont recommends cut resistant gloves such as Model #: SU-2550 obtainable from:

Medical Armor Corporation
P.O. Box 708
925 West 6th St
Fremont, Nebraska 68025
Ph: (402) 721-4700
Fax: (402) 727-4774

As with glass epoxy laminates, good ventilation when drilling panels is recommended to avoid generation of nuisance dust in the drilling room.

Waste Disposal

Dispose of CooLam™ thermal substrates by landfill or incineration, in accordance with Federal, State and Local regulations. We have taken steps wherever possible to eliminate or minimize the use and presence of materials that are specifically regulated under the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act). EPA has published two lists including (1) the 129 priority water pollutants and (2) the substances comprising total toxic organics, TTO, (40 CFR 413.02 - FR July 15, 1983, pg. 32483). None of these materials are used in CooLam™ thermal substrates.

Recycling for metal recovery is an option.

Disposal of scrap or unused CooLam™ may be governed by State or local regulations; however, scrap or unused CooLam™ is considered non-hazardous waste under RCRA (40CFR Subparts C and D - 40 CFR 261.20 through 261.33).

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For more information on DuPont™ CooLam™, please visit:

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