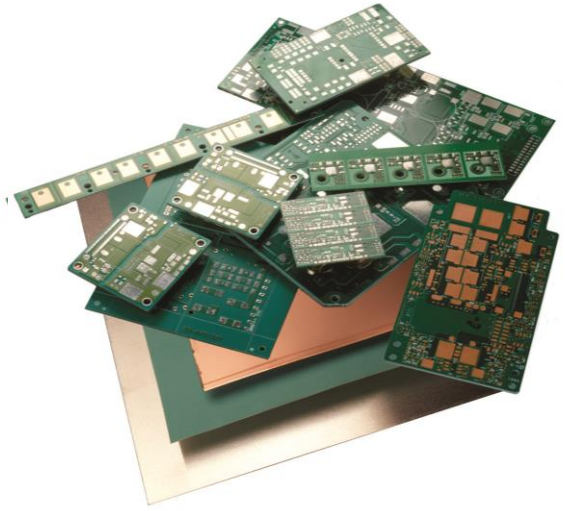
TLAM Substrates

FABRICATION GUIDE



About Laird Performance Materials

Laird Performance Materials enables high-performance electronics. We are a global company creating advanced protection solutions for electronic components and systems.

World-leading technology brands rely on us for improved protection, higher performance and reliability, custom structural designs and faster time-to-market.

We solve design issues through innovative products such as EMI suppression or absorption materials, thermal interface materials, structural and precision metals, magnetic ceramic products and multi-functional solutions. This latter product family solves multiple EMI, thermal and structural design issues simultaneously using a single process design. Industries served by Laird Performance Materials include:

- Aerospace
- Automotive electronics
- Consumer electronics
- Data infrastructure
- Defense
- Industrial
- Laptops, tablets, PCs
- Medical equipment
- Network equipment
- Telecommunications
- Test and measurement equipment
- Wearable devices

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1.0 | Sheet Material and Panel Handling

Handling and storage of the Tlam PP 1KA dielectric is critical to the successful processing and final quality of the fabricated Tlam ML. This section covers the basic procedures for proper handling and storage of Tlam materials.

Tlam PP 1KA

Tlam PP (uncured pre-preg) material is a ceramic filled epoxy sheet product. The sheets are reinforced with fiberglass that is orientated close to one side of the sheet. The material is supplied with a protective release liner on both sides. Both liners must be removed prior to any lamination process. The Tlam PP is used to bond the base metal layer to the Tlam DS layer of a Tlam ML PCB. Tlam PP is typically supplied in 0.006" to .012" thickness and 18" x 24" sheet dimensions.

Tlam DS 1KA

Tlam DS material is a double-sided circuit pair substrate with two sheets of circuit copper bonded together with Tlam 1KA dielectric. The Tlam DS substrates are typically supplied in 18" x 24" dimensions.

Tlam SS 1KA

Tlam SS material is a single layered laminate with copper foil, PP dielectric layer, and a thick base metal layer of either aluminum or copper. The Tlam SS is supplied in 18" x 24" panels without etch-protect masking on the base metal material.

Handling Procedures for Tlam Materials

The Tlam materials should always be handled with hand protection to prevent cuts and abrasions from sharp edges as well as transferring oils and contamination to the bonding surfaces.

The Tlam DS should be handled in the same manner as any thin core laminate product. Support in the form of trays or racking is necessary to maintain flatness and to minimize fracture of the epoxy dielectric.

Storage of Tlam Materials

Storage of Tlam substrates is similar to FR4 materials. Contact your local Laird Technologies Sales office for information on material warranty.

Tlam PP 1KA should be stored in a controlled environment of 20 – 25°C and 45 – 55% relative humidity.

Tlam DS and SS substrates should be stored in a dry 40 – 60% relative humidity and cool 25 – 35°C room. This substrate is fully cured and does not have a shelf life.

Leave the Tlam material in the primary packaging until it is time to use. Slide the boxes of Tlam PP across flat surfaces instead of lifting the boxes from the ends.

Inventory System – Fabricator should always use FIFO inventory system.

2.0 | Panel Presentation

Proper set up for tooling and registration is required prior to any manufacturing steps. This chapter outlines and describes the methods for successful set up.

Compensation/Scale Factor

Artwork scaling may be required to allow for material movement during lamination and etching operations.

Here is a compensation factor for our Tlam DS 1KA 08 03/03 material. The information has been calculated for an 18" x 24" panel. When working with different foils weights, you may need to increase or decrease the compensation based on the copper weight of each layer and percentage of copper fill. The compensation factor is applied to the artwork prior to photo plotting and does not include etch compensation for the copper weight. The core thickness for this calculation is Tlam DS 1KA08 03/03 substrate.

- X Axis 18" dimension the total compensation is 0.007" or 1.00038" factor per inch.
- Y Axis 24" dimension the total compensation is 0.012" or 1.0005" factor per inch.

3.0 | First Step Drilling

Drilling of the Tlam substrate is accomplished through standard drilling techniques. The details included are a guide to some of the critical operations.

Stack and Pin

Orient the Tlam DS substrate to match the drill program. Stack and pin per standard thin clad FR4 laminate procedures. Use either foil board or composite backup material and appropriate entry material.

Multiple panels can be stacked based upon drill condition and flute length.

Drilling of the Tlam DS

Drilling of the Tlam DS substrate is accomplished using standard feeds and speeds for FR4 material. Adequate vacuum and pressure foot is required to maintain a clean hole and debris removal.

Hit Count and Bit Wear

The drilling of the Tlam DS substrate can produce slightly higher bit wear and hit counts should be managed accordingly. Typical hit counts for hole diameters under 0.093" should be between 1000 – 1500. Hit counts for hole sizes larger than 0.093" may run from 500 – 1000. Last hit coupon holes are recommended and review of tools during initial trials is recommended.

Post Drill Cleaning

Any of the acceptable methods for cleaning/ deburring thin core FR4 materials will yield satisfactory results on Tlam DS substrates. Handle the Tlam DS substrate with care to prevent damage. Follow equipment manufacture guidelines for set up and maintenance of cleaning process.

4.0 | PTH Process

Applying plating in thru-holes is critical to the success of any double-layer or multi-layer board. Tlam material is compatible with most process chemistry. Hole condition and panel surface treatment are important to the success of any plating process.

Pre-Plate Cleaning/Desmear

Prior to any thru-hole plating the panel must be cleaned/desmeared. This can be accomplished by two basic means:

- The first method used is plasma desmear. Follow the manufacturer's guidelines for set up and operation of plasma equipment.
- The second method is chemical desmear. Usually achieved by using a sodium or potassium permanganate solution preceded by a solvent solution to enhance the effect of the permanganate. In any desmear operation, caution must be taken to reduce the attack on the epoxy due to the lack of fiberglass volume in the Tlam dielectric. A guideline to follow is to reduce the cycle time by 50% in any of the desmear operations and measure the effectiveness before proceeding. Modifications to the cycle time may be required.

Plate Thru-Hole Methods

There are many methods to create PTHs in the Tlam DS substrate. We will define the most common processes of hole metallization. Tlam substrates are compatible with most PTH processes.

Electroless Copper – Low, medium, and high deposition baths are compatible with Tlam materials. No specific changes to the cycle are required. Weight gain coupons are recommended to ensure complete coverage and proper deposition rate.

Direct Plating – Tlam is compatible with most direct plating chemistries. Trial runs to prove coverage and reliability are recommended before production quantities are processed.

Flash Cu Plate – Some manufacturers require a copper flash plate prior to primary image. There are no known problems associated with this process. Follow established electroplating procedures and handle the Tlam DS substrate with care, as thin laminates can bend and crack easily.

5.0 | Primary Imaging

Imaging of the prepared Tlam DS substrate is accomplished under semi-clean room conditions utilizing the processes described below.

Dry Film Application

1.3 to 2.5 mil aqueous developable dry film photo resist can be applied to the cleaned Tlam DS substrate. Standard hot-roll or cut-sheet laminators are acceptable. Slower than normal lamination speeds may be required in order to bring the metal-based material up to proper lamination temperature.

Wet Film Application

Some liquid or wet film photo-resists are available. If a wet film photo-resist is selected, follow the manufacturer's suggested application method. Apply material to a cleaned panel. Double-sided coating can be used to protect base metal during etching. Follow the manufacturer's recommended tack dry, exposure, develop and post-cure guidelines.

Screened Image Application

There are two primary types of screen printable etch resists: thermally curable and UV curable. Currently, most fabricators are using UV curable etch resist inks.

Panels must be clean and free from fingerprints and dirt prior to screening. Preparation of the image screen should be handled per stencil manufacture instructions. Curing should follow the manufacturer's recommended guidelines.

Developing

Most dry film and wet film products develop in a mild caustic solution. Protection of the base metal is not required for developing solutions. However, if applied, the base metal etch mask will withstand developing chemistry. Follow the manufacturer's recommended guidelines for temperature, speed, and solution

6.0 | Wet Processing

Wet Processing can be one of the most difficult parts of Tlam DS fabrication. Thin core material can be a challenge to most PCB fabricators. Care and attention in racking, handling, and transportation is required.

Electrolytic Plating

Tlam DS substrates are compatible with most acid copper and tin or tin/lead plating baths.

Dry Film Stripping

Follow the manufacturer's guidelines.

Etching

Tlam dielectrics do not react to ammoniacal, cupric chloride, or ferric chloride etchants. Follow standard etching procedures for copper weights. Handling procedures for thin core material should be followed.

Etch Resist Stripping

Stripping the etch resist off the panels can be accomplished by two primary processes. The first method is rack, dip, and rinse. Due to the limitations of this manual process and the possibility of excessive attack on the base metal, this is not the preferred method.

In-line conveyorized stripping is the preferred method. Depending upon the resist material used, the stripping solution makeup, temperature, and dwell time in the spray chamber will vary. Consult your resist supplier for exact specifications and process details.

Post Etch Cleaning

This procedure is a pre-mask preparation. Mechanical and/or chemical cleaning of the copper surface is required to prepare the surface for solder mask application. A 320-grit bristle brush or compressed fiber brush will work adequately. Pumice or oxide slurry will also work if available. A water break test will confirm proper surface cleanliness.

Copper Adhesion Promotion

Prior to lamination to the base metal material, the etched DS panel requires copper adhesion promotion (oxide treatment). Most black, brown, or other adhesion promotion chemistries work satisfactory with Tlam substrates. After application of the adhesion promoter, a bake cycle is recommended to remove any moisture from the Tlam DS substrate. A 30-minute bake at 150°C is usually adequate.

7.0 | Multi-layer Process

The fabrication of a two-layer PCB should follow the following process to minimize handling issues with the thin Tlam DS substrate. Print and etch the buried side of the Tlam DS substrate and laminate to base plate prior to etching the second side. Finish the top surface of the two-layer PCB per the customer's requirements.

For four-layer PCB, repeat the process of etching the buried side of the Tlam DS substrate and laminate to the two-layer PCB fabrication above. Finish the top surface of the two-layer PCB per the customer's requirements.

8.0 | Lamination Cycle

The lamination cycle or bonding operation establishes the mechanical and electrical integrity of the Tlam ML PCB. Following guidelines can help to ensure uniform panel characteristics, including an even bond line and good final test results. The press procedure is a starting point and as experience increases, you may find better methods and modifications to the procedure.

Material and Base Metal Preparation

Aluminum base material can be cleaned by using an in-line scrubber or deburr machine equipped with 240 – 320 grit bristle brushes. A sufficient water rinse and heated dryer are recommended. All aluminum panels should pass the water break test after surface scrubbing.

A more advanced way to prepare the surface is to use a hot alkaline clean followed by 3X CFR DI, a pumice slurry followed by 3X DI CFR, and a hot air rotary dry. The aluminum will contaminate the pumice slurry, so keep this in mind if it is also used for copper.

See the application note regarding Aluminum Panel Surface Preparation for more details.

Copper base material needs surface treatment to stabilize the bonding surface of the copper. Black, brown, gold or other oxides work satisfactorily.

All panels should be dry and free from contamination prior to lay-up.

Lay-Up Preparation

Prepare base metal by either mechanical cleaning and/or chemical cleaning. Clean and dry panels prior to lay-up. Aluminum panels must allow no water break to pass.

Clean and prepare press plates for booking operation. Inspect for dents, pits, and resin flash and surface irregularities. Remove plates that cannot be prepared.

Have correct quantities and sizes of PP, press pad, release film and copper foil.

Book Lay-Up

The Tlam ML 1KA fabrication incorporates the aluminum or copper base plate to the etched Tlam DS substrate with Tlam PP 1KA. These plates also act as separator plates. This means the stack up does not required the stainless-steel separator plates. The stainless-steel plates will reduce productivity by taking up space in the book and slowing down the temperature ramp in the press.

Use the following book lay-up:

MULTI-LAYER PCB LAY-UP

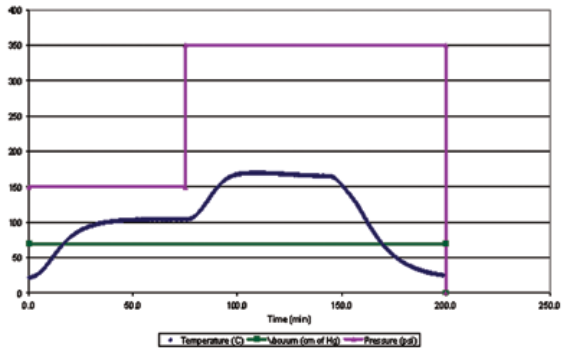
Press plate
Two sheets of press paper

Tlam DS sheet
Tlam PP sheet
Base plate

Repeating segment
Total thickness of 2.5"

Two sheets of press paper
Press plate

1KA Panel Profile



Press Profile

Use the following profile as a starting point for the press cycle. The temperature profile indicated is the temperature that the center panel in the book should read. Thermocouples placed in the middle of the center base plate should be used to verify the temperature ramp. Once the correlation is between the press setting and the press temperature ramp, it is no longer required to monitor the pressing operation.

Profile Description:

1. Load the booking into the press.
2. Pull the vacuum to >70cm of Hg.
3. Apply 150 psi of pressure.
4. Increase the temperature to 105°C at a rate of rise of 4°C per minute*.
5. Hold for 45 minutes once the temperature has reached 105°C*.
6. Turn up the pressure to 350 psi and increase the press temperature to 165°C at a rate of rise of 4°C per minute and let cure for one hour at 165°C*.
7. Cool the book at 4°C per minute until it is handleable.

De-Booking and Epoxy Removal

Exercise care when de-booking the panels and inspect for excessive epoxy squeeze-out in the PTH areas of the panel. Epoxy removal from the surface of the panel can be achieved through the use of mechanical, chemical, or plasma technology. Experimentation using the process is recommended prior to production use. Plasma and mechanical removal has proven to be the most consistent and non-damaging to the base metal substrate.

Post Bake of Tlam PCBs

Panels can be post baked for one to one and-a-half hours at 175°C to ensure total cure and to stress-relieve the material. This is an optional process.

It is a good step to validate that the process used to laminate the DS layers together and/or to base plate preparation is acceptable. Blisters will form between the aluminum base plate and circuit copper if the surface is not prepared properly.

9.0 | Post Lamination Drilling/Punch and Second Step Drilling

After lamination and epoxy squeeze-out removal, the panels are ready for registration tooling and second- step drilling. These operations involve machining of a composite material with a solid metal base that prove challenging to PCB fabricators. Exercise extreme caution when performing these operations.

Post Lamination Registration

After lamination, tooling holes will be required to align the solder mask and any secondary machining operations, i.e., NPTHs, V-score tooling, and other fabrication steps.

Spot Face Drill

Spot face drill has been the most accepted means of locating and adding registration hole tooling after lamination. Due to the base metal substrate, drilling is usually less destructive than post lamination punching. Use feed rates of 0.001" – 0.0015"/rev with spindle speeds of 24,000 – 30,000 rpm. A strong vacuum is required to extract chip and debris from the hole and to cool the drill bit properly. Drill feeds and speeds should match that of solid metal removal settings. Low-chip loading and slow-in-feed rates are recommended.

Post Lamination Punch

In the event that spot face drilling is unavailable, post lamination punching can be used to locate and add registration holes. Care must be taken as solid metal substrate punches with more force required than typical FR4 multilayer panels. Refer to the equipment manufacturer's suggestion prior to attempting this operation.

Second Step Drilling or Pierce Punching

Second Step Drilling – Uses a feed rate of 0.001" – 0.0015"/rev with spindle speeds of 24,000 – 30,000 rpm. A strong vacuum is required to extract chip and debris from the hole and to cool the drill bit properly. Stack heights of up to four panels can be used if the drill bit is sharp and no burring is present. Entry material and hard backup board is required to minimize burring.

Pierce Punching – Similar to tooling or registration holes, a well-constructed punch and die set is required for proper hole quality. Refer to the local tool and die manufacturer for specific details of tool construction and use.

10.0 | Solder Mask Preparation and Application

Solder mask material has been used for many years in PCB production. In the case of Tlam PCBs, the uniformity, cleanliness, and overall cosmetic appearance are critical factors. Using mechanical scrubbing with a 320-grit bristle brush, pumice slurry, or chemical cleaning will work sufficiently.

Liquid Photo-Imageable Solder Mask

LPISM is the most common version of coating boards prior to finishing. Application by screening, spraying, or curtain coating can give satisfactory results. Thicker copper weights may require double-passing to ensure complete coverage and adequate thickness at the knee of the traces and land areas. Contact your ink manufacturer for the exact process details.

Thermal Cured Solder Mask

Thermal cured solder masks have been used for the longest time. Due to the advancement in LPISM and UV cured masks, thermal masks are not in as great of demand. However, they still perform very well if the proper surface treatments of the copper surface and correct curing schedules are followed. The most common thermal mask products are either a one-part or two-part mixture, or pot life is a consideration. Follow the manufacturer's recommended process directions for best results.

UV Cured Solder Mask

This is not a recommended process for Tlam products.

Dry Film Solder Mask

Dry film solder mask has been used for the past 12 – 15 years on higher density circuitry due to the increased definition and relative ease of the application. In some applications this may be an appropriate mask choice, but for general applications this method is not recommended.

11.0 | Finishing Operations

In order to prepare the Tlam top surface for component placement and assembly, the exposed copper surfaces must be treated to ensure adequate solderability, proper wire bond strength, and overall manufacturability. A variety of coatings, plated metals, and conversion treatments are available. Below are four of the choices:

Hot Air Solder Leveling

Hot Air Solder Leveling (HASL) is currently the preferred choice of finish on Tlam PCB. Either horizontal or vertical application is acceptable. At this point the base metal mask, if used, must be removed. Fluxing, preheating, application and post cleaning all follow standard FR4 process methods. An increased dwell time in the solder pot may be required to allow the panel to reach temperature. This may reduce machine cycle frequency to allow for solder pot

temperature recovery. The Tlam substrates act as a heat sink and require an increased dwell time. Prior to post cleaning, the coated panel may have a black or grayish smut coating on the base metal side of the panel. The smut can be removed by an aggressive aqueous cleaning cycle and mechanical brushing.

Organic Solderability Protection

When using an Organic Solderability Protection (OSP), the base metal may require masking to protect the OSP chemistry from contamination. OSPs have shelf life limitations ranging from three weeks to three months. Care in handling the coated boards is required. Some OSP products allow exposure of metal without degradation to the chemistry. Contact the chemistry supplier for process details.

Immersion or Electroless Tin

Similar handling procedures to OSPs are used when applying immersion or electroless tin coatings to SS parts. The base metal must be covered to protect the tin chemistries from being contaminated. As with OSP coated parts, tin coated parts have shelf life limitations ranging from one month to six months. Care in handling the coated boards is required. Refer to the chemistry supplier for process details.

Ni/Au or Nickel/Gold

Ni/Au or Nickel/Gold coatings are popular with wire bond applications. Ball bond, ultrasonic bond, thermosonic bond and wedge bond techniques all require a Ni/Au bonding surface. Hard low-to-medium phosphorus nickels are mostly used for the pure soft gold top coating. Each customer will have specific requirements and the chemistry supplier will need to be contacted to define the correct plating baths for the operation.

12.0 | Fabrication

This section will cover the aspects and procedures to palletize the singulate and finish the SSs into shippable units. We will discuss the three primary means of fabrication, routing, V-scoring and punching.

Routing

Routing is used for low-to-medium volume quantities. The proper tool selection along with a mist spray of water-soluble cutting fluid is required for best results. Using the double-fluted carbide router bit designed for metal removal is essential. A 0.093" – 0.125" diameter with a spindle speed of 18,000 – 24,000 rpm, a chip load of 0.0015" – 0.003"/rev and a table travel of 22" – 40"/minute is recommended. Megatool, Tulon, and other carbide tool suppliers provide suitable products. Adequate vacuum and cutting fluid is required to maintain tool life and minimize burring. Stack heights of one to four panels are possible.

V-score

V-scoring is a very popular and economical method of fabricating low-to-high volume quantities of Tlam products that have square, non-radius corners. Minimum set up time and fast thru-put make this a logical choice of fabrication. Both singulation and palletizing is accomplished with V-scoring. V-scoring uses a 30 degree 25-55 tooth zirconium nitride coated carbide steel or diamond tipped blades with a feed rate of 5 – 10 /fpm at a blade speed of 5000 – 15000 rpm. Water-soluble cutting fluid is recommended. Multiple passing increases the depth of score until a .008" – .012" web remains, reducing the burrs.

Punching

Single cavity or multiple cavity dies work with Tlam substrates. Specific tooling instruction is available through local tool and die manufacturers. The fillers in Tlam 1KA dielectric will not wear the die and actually act as a lubricant.

13.0 | Final Testing

Due to the nature of the metal base materials, hipot testing must be performed on all parts to ensure isolation of the circuitry to base metal. There are a variety of test methods, fixture constructions, and equipment types to accomplish this task. This portion of the guide will only cover the basics. Customer specifications will dictate the actual test requirements.

Electrical Test

Standard electrical test fixtures will work for continuity and open testing on Tlam PCBs. Net list testing to ensure 100% electrical integrity is recommended.

Many universal grid and flying probe testers work on Tlam PCBs. Contact the test equipment manufacturer for any specific details.

Hipot Testing

Hipot testing is performed using a modified spring- loaded bed of nails fixture. Using net list data and only contacting one or two points per net a fixture is built to connect all the foil circuitry on the Tlam PCBs. A test voltage of 500 – 2500 VDC for up to one minute is applied to the circuitry through a low current isolated supply. The base of the Tlam PCB is connected to a ground. Minimal leakage current may be detected during ramp up to final test voltage. A 500 volt per second ramp may be required to eliminate false failures triggered by capacitance build up in the Tlam dielectric. A ten second – one minute dwell may be required on each part. See customer specifications for exact test parameters and requirements.

14.0 | Packaging

Packaging of the finished Tlam PCB is important to minimize chaffing, scratching, and abrading to the surface of the boards.

Interleaving with a low sulfur release sheet and vacuum sealing stacked boards is a good method of packaging Tlam PCBs. Also, individual wrapping and bubble packaging can be an alternative. It is critical to not stack the board's solder coating to aluminum without separation or slip sheeting to eliminate galvanic reaction to the dissimilar metals. Loose stacking of boards does not present as great of a problem as tightly packed sealed stack of boards.

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