DuPont ElectronicTechnologies

CB100 VIA PLUG

PROCESS GUIDELINES

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Introduction

CB100 Via Plug Process

This process guide provides an overview of the features, benefits, and applications of polymer thick films (PTF) as via plug materials. The ever increasing density demand for BGA's and surface mount technology requires the designer and printed wiring board (PWB) manufacturer to fully utilize the available area for PCB and packaging applications. In an effort to reduce the impact of wasted space, the via hole has gone from a through via to a buried via/blind via to a micro via. The use of polymer thick film via plug material prevents the entrapment and bleed through of materials in through holes, as well as providing increased surface area, better thermal management, and enabling padless via technology for BGA's and surface mount technology. This process is a cost effective alternative to filling with low reliability solder masks, epoxies, and the least cost effective method of plating the vias shut.

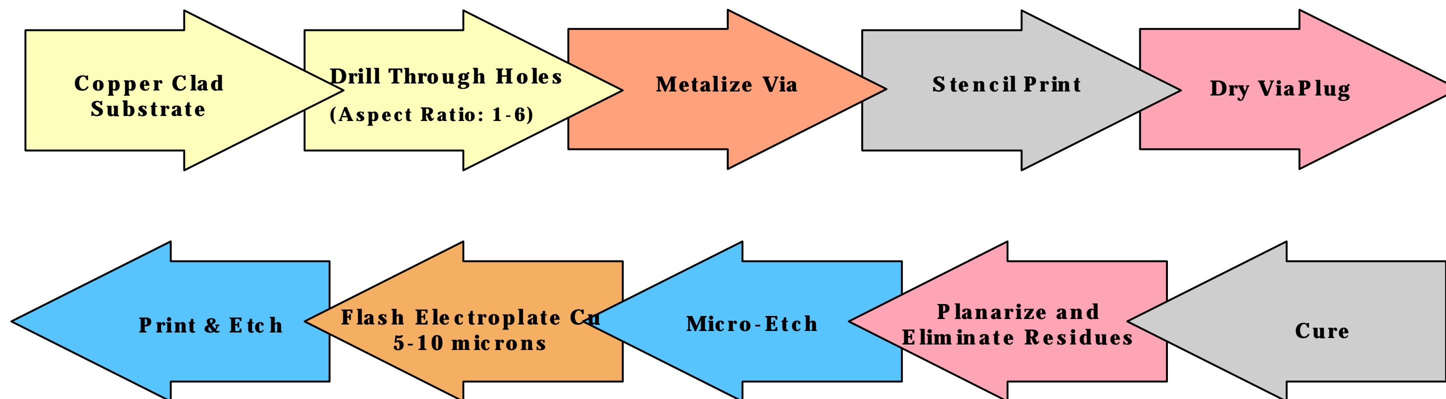
The via plug process uses standard stencil printers / screen printers with optimized squeegee material for efficient fill. Planarization of the surface of the panel is accomplished with available off the shelf equipment with a minimal capital investment. These guidelines will enable users of the via plug process to understand the techniques, process, applications, and dimensions for plugging vias.

Information will be provided for various PWB configurations that offer the greatest possibility of success. While some users may attempt to pursue using these techniques beyond the recommendations in this guide, their opportunity for success will require the user to understand and develop processing techniques unique to their specific applications.

CB100 Via Plug Ink

Feature	Benefit
Stable one-part silver / copper epoxy	Longer shelf and operating life. No mixing required
Multi modal metal system	Ensures dense packing Doesn’t shrink during cure
Electrically conductive	Improves thermal conductivity of through holes Plated through hole replacement for buried vias
Filled holes planarize board surface	Recovers lost real estate enabling via on pad application
Prevents contamination penetration	Higher reliability
Processes on commercially available equipment	Low capital investment

Process Flow Diagram:



CB100 ViaPlug Process

CB100 Via Plug Design and Process

CB100 conductive via plug materials are formulated for the purpose of filling vias and through holes with a solid conductive and planarizable flat surface. One advantage of conductive via plug is its inherent thermal conductivity.

In often used dense ball grid array designs, a large number of holes on tight pitches are filled with CB via plug thus forming a large mass of metal for heat conductance in a concentrated area. This concept allows destructive heat to be dissipated from high power active devices to a heat sink.

Designers and fabricators must consider the mass of metal in CB100 via plug as layer counts and densities of boards increase.

The CB100 via plug process has been optimized for filling vias in circuit boards that are less than or equal to 0.085 inches thick while observing the 6:1 board thickness to via diameter ratio. CB100 via plug paste is not recommended for via diameters greater than 0.018 inches in diameter (drilled). Use of CB100 via plug outside this range will require process development by the user for their individual design.

Drying and Cure

If high-density high layer count boards filled with CB100 via plug are not completely cured, it is probable that complete cross-linking may not occur in the center of the via. Exposing these configurations to high temperature excursions like Hot Air Solder Leveling (HASL) or high temperature oil dipping may cause accelerated cure leading to expansion of the fill. In these situations, the heat is entering the board from both top and bottom of the board simultaneously. This allows no avenue for the heat to escape except through the sidewalls of the via.

The curing schedule may have to be extended for thicker and denser boards due to the amount of buried metal and organic which will absorb heat during temperature excursions (like HASL and oil dipping).
Be aware of heat excursions at assembly and re-work.

Design

Carefully select panels with a high enough glass transition temperature (Tg) to withstand the temperatures to which the board will be exposed.

DuPont CB100 Conductive Via Plug Process Guidelines

This process is for plugging through hole vias using DuPont's CB100 via plug paste. This material provides high conductivity plateable vias for PBGA's, build-up substrates, and standard PWB's. It provides a simple low cost method to create plugged, planar and thermal vias using conventional equipment.

SUBSTRATES

CB100 via plug paste has been optimized for high thermal and electrical performance. It may be used as a plated through hole replacement for thin double sided boards or in the fabrication of buried vias.

Recommended use substrates:

Thickness	0.008 " to 0.085”
Drilled via size	0.008" to 0.018"
Aspect ratio	1:1 to 6:1
Base material	Copper clad FR-4, Modified FR-4 epoxy, BT resin based
Vias	Metallization of the via prior to plugging with a recommended minimum of 0.5 mil copper is required for multilayer boards.

Surface Preparation
Generally there is no need to prepare the via hole for improved adhesion. Heavily oxidized substrates may be mildly acid washed or micro-etched. Via holes should be clear of all drilling debris and copper nodules. Partially blocked vias will inhibit complete filling.

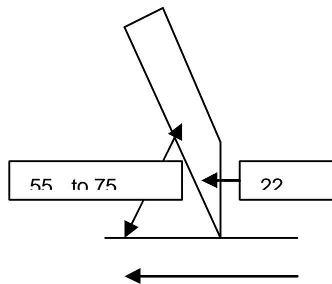
CB100 Via Plug Process
The process to properly fill vias, storage of the paste, processing equipment, materials, and conditions follow.

Material:	CB100 Via Plug Paste
Viscosity	115,000 to 145,000 cp 115 to 145 Pa.s
Specific Gravity	~5.5 grams / cc
Storage Conditions	Refrigerate between 2° C and 5° C (35° F and 41° F) when not in use. Leave unopened container at room temperature for 2 hours before opening the container to ensure water does not condense in the paste.

Stencil Printing

Stencil printing is required for optimal via fill. The apertures (openings) in the stencil should be 0.012 inches larger than the via to be filled. This allows an adequate volume of paste to be placed over the via for complete fill. This enlargement may have to be reduced in areas where tight-pitched ball grid arrays exist.

Stencil Type	stainless steel
Thickness	3 or 4 mils
Finish	electropolished
Tension	mesh tension prior to mounting the metal foil 20-30 Newton's/cm
Squeegee Type	polyurethane 70 -80 durometer >/ = 0.375 blade thickness 22 degree cut angle
	55° to 75° squeegee attack angle the squeegee attack angle is adjusted depending on the board thickness
Print Speed	typically 1 to 5 cm/second Adjust squeegee pressure until the squeegee wipes the surface of the stencil clean.



Printer

Standard screen printing equipment modified with uniform vacuum assist. Vacuum holes outside the board dimensions should be sealed off to deliver the maximum pull in the board area. Placing a piece of porous paper between the bottom of the board and the printer vacuum plate eliminates clogging the vacuum plate with excess paste.

Snap Off

Snap off (breakaway) of the stencil from the surface of the board should be from 10 mils to 100 mils as needed to completely fill the via and eliminate smearing of the paste.

Hold Time

The filled panels may be held from 0 to 12 hours between printing and drying.

Drying

Drying and curing should be done in a forced hot air oven. IR curing and drying is not recommended.

The drying step must be done as part of the process. At this stage volatiles are driven out of the paste and prepare it for curing.
By not properly drying the filled boards, vapors will become trapped in the center of the via and could out-gas at the higher curing temperature.

Dry between 110 ^{o}C and 115° C (do not exceed 120° C), for 30 minutes minimum. For thicker panels, the dry time should be increased.

Curing

Temperature	160° C to 165°C
Time	60 to 75 minutes

Planarization

The planarization step removes residual paste (nail heads) from the surface of the board and delivers a flat and smooth surface.

Equipment Recommendations:

Wet de-burring or a scrubbing sander with a re-circulating particle filtration system has been successfully used. The system should have a rinse at the end of the cycle. (See equipment section for details)

Metallization and Imaging

Electroplating the planarized CB100 material and copper clad surface encapsulates the via plug. The board can be either panel or pattern plated, using a standard plating processes. Use of electroless copper or direct plate may be used, but it is not necessary

CAUTION
Exposure to de-smear or plasma etch processes should be avoided since it will aggressively attack the CB100.

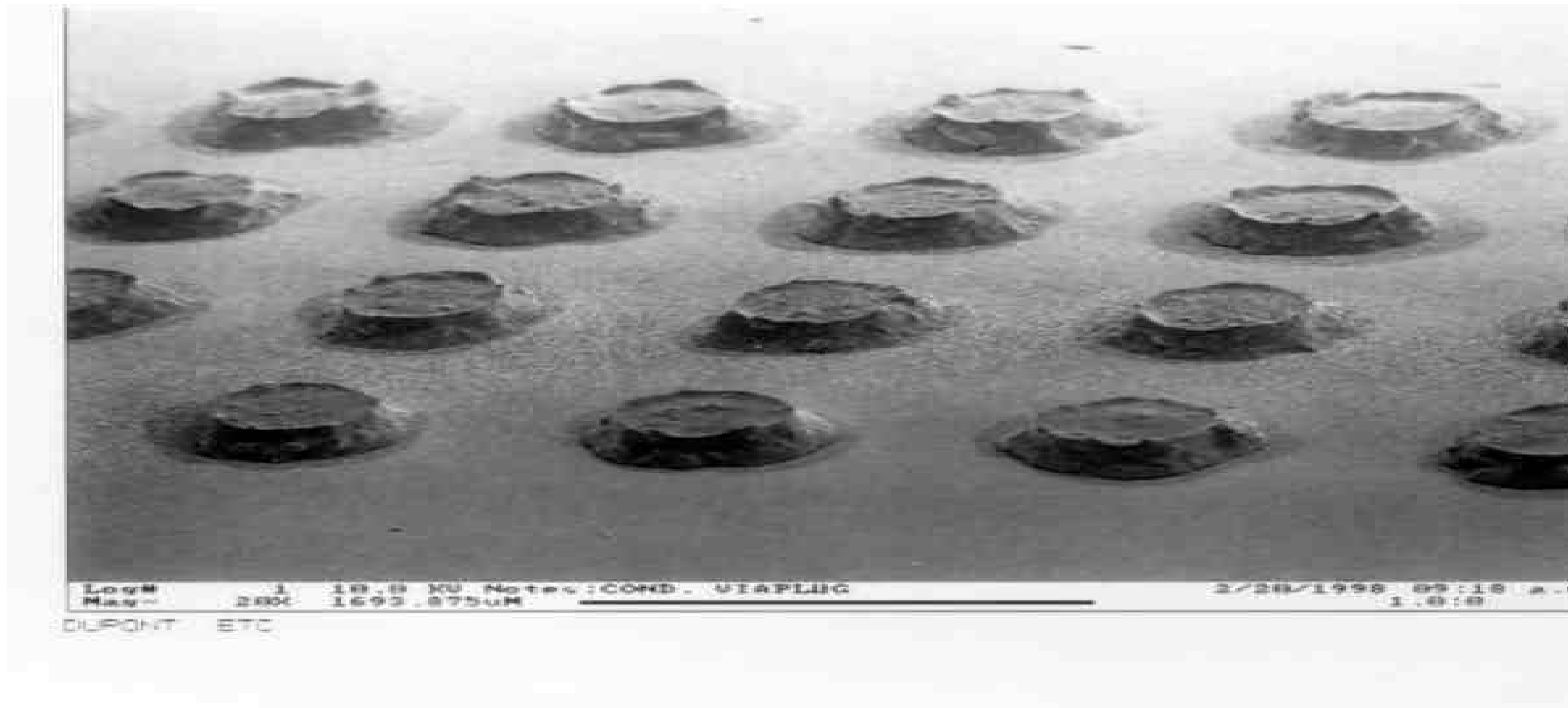
Pre-plate Cleaning, panel or pattern plating

Acid cleaning per vendor recommendation

Micro etch per vendor recommendation

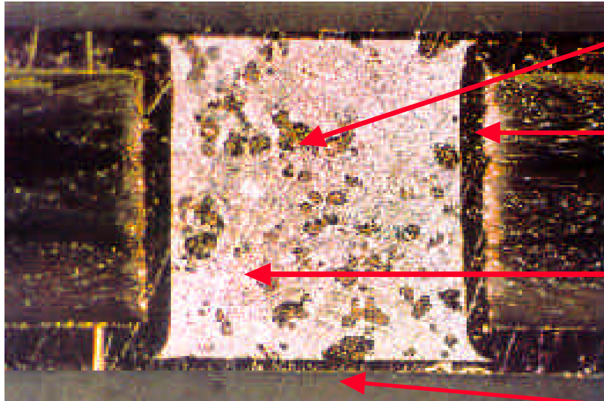
Cu electroplate, 15 - 20 ASF
(0.2 mils minimum is recommended)

Surface After Printing



After printing, small bumps (nail heads) will be in place over the through hole. These are the result of excess paste that fills the openings of the stencil thickness. The nail heads are removed after fully curing the paste by the planarizing process.

CB100 Filled Hole After Plating



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ViaPlug

DuPont Photopolymer & Electronic Materials

Planarization Options
Belt Sander

http://www.dupont.com/mcm

ViaPlug

DuPont Photopolymer & Electronic Materials

Planarization Options
Scrubbing with Buff and Ceramic Rollers

http://www.dupont.com/mcm

Commercially available equipment for the planarizing process includes belt sanders and ceramic-coated scrubbers and buffers. There is an assortment of sandpaper grits and buffer roller finishes available. Selecting the right combination of abrasives and transport roll hardness (durometer) will produce totally flat plugged vias.

Pictured top/left is an oscillating belt sander from Timesavers, Inc. Bottom/left is the ceramic roll scrubber from IshiiHyoki, Inc. Both types of planarizers have proven to be effective.