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High-density Interconnection (HDI)

Advances in component technology are causing changes in PWB manufacturing and construction. To assure its position as the preferred interconnect system for the electronic industry, new manufacturing procedures are in development to fulfill the higher performance demands of the future.

The Evolution Of Attachment Techniques

In 1996, insertion-mounted components represented less than 20 percent of the component market—as compared to 100 percent in 1980. In the past, size, shape or weight has required components to be secured by solder in plated through-holes by wave soldering. As advances in component technology rapidly reduce this number, solder paste and preform techniques emerge as realistic approaches to replace wave soldering.

Economic consideration has dictated designs where chips are secured by glue on the bottom side of PCBs, and then attached by wave soldering in one operation with insertion-mount components. The elimination of wave soldering opens up design potential favorable for increasing packaging density.

Fine-pitch integrated circuit packages with more than 200 I/Os and MCM-Ls are creating a need for more advanced bonding techniques, such as wire bonding, tape automated bonding (TAB), chip on board (COB), direct chip attachment (DCA), ball grid array (BGA), flip chip, etc.

Limitations of HASL

Currently, most specifications call for an HASL surface finish because of its reputation for solderability. If the finish is bright and shiny—with no visable evidence of dewetting—and meets thickness specification, solderability is assured, even with "leave on" fluxes.

With fine-pitch components (<0.38 mm/0.015 in.), however, problems with placement and bridging appear. This is caused by the meniscus formed when molten tin-lead solidifies, and by thickness variations caused by thermal non-uniformity. In addition, some of the advanced bonding procedures are not compatible with HASL (*e.g.*, wire bonding).

Alternatives to HASL

HASL substitutes now in use or under investigation include electroplated/electroless nickel-gold, electroplated/electroless nickel-palladium alloy, palladium, organic solderability preservers (OSPs), electroplated tin-nickel, immersion tin and immersion silver.

Limitations of Mechanical Drilling

High-density interconnection is causing a strain on traditional fabrication processes. The need for more and narrower holes per unit area (vias <100 microns/0.004 in.) is approaching the limit for mechanical drilling. A great deal of research is currently being devoted to unearthing alternatives to traditional drilling.

Next Generation MLB

Investigatory methods to yield micro-vias include:

- Photo imaging
- Plasma
- Laser
- Chemical
- Mechanical

Metallization can be realized by traditional additive and subtractive techniques, direct metalization and conductive ink.

Sequential build-up is a revolutionary new approach for producing multilayer PWBs with micro-vias. The following methods are currently undergoing scrutiny to effectuate build-up circuits:

- Surface laminar circuits
- Sequential bonded film
- Film redistribution layers
- Conductive adhesive bonded flex
- Build-up structure system
- Sequential bonded cores
- Carrier formed circuits
- Roll sheet build-up
- Sheet build-up

The goal of avant-garde technology is to add large quantities of small blind vias at a cost well below conventional drilling. With nine techniques in production or being evaluated, it is understandable why very little information has been published on cost and reliability. It is quite possible that micro-via technology can reduce layers from existing products. This would reduce fabrication costs, because layer count is a major expense factor.

Micro-via manufacturing could well be as revolutionary to PWB fabrication as epoxy glass multilayer technology was when first introduced in 1965. Which of the many procedures now in use or being investigated will prove the most cost effective and reliable technique? Time and testing will tell. **P&SF**