Circuit Technology



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Streamlining PWB Manufacturing

Plated through-hole (PTH) metallization with electroless copper was first introduced in the early '60s. Although the procedure has been continuously improved over time and is considered to be reliable, there are certain disadvantages. These include:

- Processing time
- Numerous steps
- Precise monitoring
- Exact replenishment of all chemicals
- Extensive waste treatment

This lengthy, multi-step procedure has always been viewed as one of the major roadblocks for simplifying and streamlining PWB manufacturing.

Direct Metallization

The alternative to electroless copper metallization is a process whereby the non-conductive surface of PTHs/vias is rendered conductive so that electroplating can be directly applied.

During the last three years, the number of PWBs manufactured by direct metallization (DM) has increased dramatically. This is a significant change for an industry that, for more than 30 years, has relied exclusively on electroless copper to metallize PTHs/vias. DM processes were first introduced in the late '70s, with widespread promotion of those based on carbon technology in the '80s.

Environmental concern for the constituents in electroless copper was the motivating factor (*i.e.*, formalde-hyde, cyanide, and chelating agents). The DM process, however, was introduced prematurely, and reports of higher costs and lack of consistent quality fostered reluctance of PWB fabricators to experiment with an unproven process.

Although the waste treatment from electroless copper systems was compounded by "bailout" (required to maintain solution balance and periodic bath changes), the total cost of a conventional electroless copper system was not significant when compared to the entire board manufacturing cost. The "If it works, don't fix it!" attitude prevailed until recently, when the benefits derived from a more streamlined and simplified PWB manufacturing process were more clearly defined.

The ever-accelerating demand for higher-density boards with more layers, finer lines, narrower spaces, and smaller vias is now the driving force for a more efficient and reliable PTH metallization system. The high cost of sophisticated PWBs requires high first-pass yields to remain profitable. DM appears to have the potential to provide this and enable the printed wiring board industry to penetrate markets with organic substrates previously reserved for ceramic hybrid circuits.

Process Selection

As recently as three years ago, less than two percent of the 4,000 printed circuit fabricators worldwide had adopted DM processes. At the Technical Assessment Forum on Direct-plate Processes held in Baltimore at SUR/FIN[®] '95, panelist estimates on fabricators currently utilizing this procedure ranged from 12–18 percent.

In contrast with past attempts to incorporate DM—which were often abandoed after initial attempts failed to fulfill promised expectations current converts are expanding use of this process.

The goal of the Technical Assessment Forum at SUR/FIN[®] '95 was to encourage the exchange of technical information, and to help users evaluate direct-plate process technology applicable to their particular requirements.

There are several proprietary DM processes, and numerous factors must be considered when deciding on the best one for a particular application. These include:

- Avaliable capital for new equipment investment
- Horizontal or vertical processing
- Type/variety of current production (*i.e.*, flex, rigid, PCMCIA, circuit density, laminate, panel size, number of layers, etc.)

- Volume of current/anticipated production
- Quality of technical support in user's area

All of the DM systems now in use have experienced success when the user gained the required expertise and adopted the necessary process improvements, including those based on carbon, conductive polymer, or precious metal colloid technology.

With contemporary approaches each containing nuances in chemical processing techniques and equipment requisites—application process predilection is convoluted. At this point in time, it is unclear whether one methodology will emerge as superior, or if each technology will have certain advantages peculiar to the particular *modus operandi*. Over time, experience with volume production will be the determinant.

Reports of significant improvement in board reliability—with respect to copper adhesion/inner layer separation—proliferate with the number of DM-PWBs manufactured. Reduced processing time, fewer procedures, and less exposure to chemicals are most likely responsible for this.

The major motive for DM is compatibility with horizontal conveyorized processing, which would allow the fabricator to utilize a single conveyor system post drill-through imaging.

Direct metallization has prompted a few companies to experiment in horizontal electroplating. Emerging success strongly suggests that total automation from drill-through etching is indeed the "coming attraction."

Impact on Electronic Industry

Continuous conveyorized processing has the potential for significant impact on PWB manufacturing. DM breakthroughs pave the way for revolutionary changes in PC fabrication. The efficiency, reliability and lower costs derived from a streamlined manufacturing process will expand current markets and penetrate high-tech areas previously reserved for ceramic hybrid circuits.