Tech Talk

Fine Lines in High Yield (Part CXXXII)

Reminiscing about fully additive processes, electroless copper, and direct metallizations

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Up front I should apologize to the readers of Tech Talk who have learned to expect solid technical information on the fabrication of advanced PWBs and packages. But this time I am tempted to reflect on some changes in the metallization of PWB we have experienced during the last twenty odd years, an endeavor that clearly dates me.

Direct Metallization Revisited

Ten to fifteen years ago direct metallization processes were making headlines. They provided topics for special sessions at technical symposia, and prompted the EPA to sponsor a "Making Holes Conductive" study which touted the environmental benefits of direct metallization processes versus electroless copper. Since then it has become quiet around direct metallization, and it would be interesting to do a post mortem on direct metallization. Post mortem is actually not a good term in this context since direct metallizion is alive and well. So is electroless copper! Its proven track record, its reliability and industry acceptance allowed e-less copper to weather formaldehyde legislation. Engineering solutions abated health risks to workers, and we have seen the advent of new formaldehyde-free electroless copper processes. Not all formaldehyde-free electroless copper processes are new: I seem to recall a MacDermid acidic formaldehyde-free, hypophosphite-based electroless copper process that was already practiced in the mid- 1980's. Modern electroless copper lines often link all the electroless processing steps through conveyorized modules.

As far as the direct metallization processes are concerned, all three major technologies seem to have survived: carbon & graphite-based processes, conductive polymers, and palladium-based processes all have found their places in PWB fabrication. They too make use of horizontal conveyorized processing. There appear to be regional differences in the acceptance of direct metallization. Without having looked at hard data, it seems to me that direct metallization now dominates in Europe. In Japan there appears to be a reluctance to use direct metallization in a big way. Taiwan is somewhere in the middle. In China I have seen big conveyorized direct matallization lines being installed in recent years. The palladium and conductive polymer-based processes seem to be favored over carbon or graphite-based processes.

I am not aware of any direct metallization being used in semi-additive processing (SAP). Electroless copper serves as the metal seed layer in SAP. I assume that direct metallization on the SAP substrate surface will proceed too slowly, if at all, from the peripheral cathode contact to the substrate center so that the surface copper deposit will show an unacceptable "dog bone" profile, much like the copper distribution in a PTH when a plating bath with poor throwing power is being used.

Fully Additive Processes

They are dead, right? Well, not quite. There was a time when Kollmorgen did mass production with its full build electroless process and George Messner and Keith Blurton were preaching the technology. The last shop in the Western Hemisphere to practice this technology was Adiboard (Itautech, Brazil) but I think they closed since I last visited them a few years ago.

Who remembers the Michaelson Process (US Patent 4,581,301, April 8, 1986)? Mr. Michaelson pre-drills a dielectric substrate, screen prints a seed layer pattern on both surfaces and onto the hole walls. The seed layer is carbon in an epoxy matrix. Then one side of the board is brought in

close contact with the cathode surface in a copper electroplating bath. The seed layer pattern on the non-covered side receives current through the many holes from the backside of the board as copper is plated up. This is then repeated on the other board surface. I don't know if this was ever practiced on an industrial scale.

Then there was the process by John Dorey et al (assigned to AT&T): a dielectric substrate is covered with an aqueous processable photoresist which is exposed and developed. The dielectric at the bottom of the developed resist channels is subjected to a swell and (chromic acid) etch treatment to create a porous surface. This surface is then catalyzed and a flash deposit of copper from an acidic hypophosphite electroless copper bath is formed. The photoresist, and any unwanted copper deposit on its surface are then stripped and the copper seed layer is built up in a full build electroless copper bath.

As far as I know, Hitachi still practices a fully additive process for very high layer count (over 40) multilayer boards, taking advantage of the excellent throwing power of electroless copper into high aspect ratio through-holes. The substrate is an adhesive coated pre-catalyzed dielectric. After drilling and forming a plating resist pattern, the hole wall is treated to improve the adhesion of the electroless copper, followed by full build electroless copper deposition.

More recently there seems to be a lot of activity in forming catalyst patterns or seed layer patterns on thin films, often reel-to-reel, in a printing or laser activation process mode. The applications often appear to aim at RFID tags. The actual conductor pattern is then created with electroless copper. It is "full-build" in the sense that electroless copper is the only conductive metal being deposited, but it does not have to be very thick for this application.