Cutting Electroless Copper Costs

—and curing a few headaches in the process.

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Few processes in the modern PCB shop engender as much fear and loathing as the electroless copper line. Production is ever fearful of this process' sudden malfunction while management loathes its high costs. Examining some of the details of the operation can reduce the degree of pain and expense involved.

Preparations for Deposition

Voids, rough deposits, and plate-outs are the cost-driving headaches in any electroless copper line. While the causes of these defects may be obscure, the most important process factors in reducing these problems are neutralizing residual alkaline solutions with dilute acid and thoroughly rinsing the boards.

As a first stage in most lines, the "fingerprint cleaner" may vary from a mild alkaline cleaner to a partial etchback system. The former is the more cost-effective, even when supplemented with ultrasonics and conditioner additive. Without the high cost of desmear, this combination shakes out the majority of drill dust and provides a solid foundation for subsequent copper deposits. Unfortunately, permanganate desmear, with its attendant high costs and maintenance, is almost mandatory for multilayer work. If the process line is long enough, the use of a mild cleaner combined with ultrasonics prior to permanganate desmear will greatly reduce desmear chemistry costs and provide very good results.

Following thorough neutralization of permanganate residues, etching provides a surface keyed to receive an adherent copper deposit. Etchants are many and varied. Some, like ferric chloride, have fallen out of general favor. Mild persulphate etchants tend to attack grain boundaries and provide a good finish for copper deposition but are becoming expensive to use and need frequent replacement. Etchant choice is more dependent on cost and effluent disposal considerations than on quality.

Subsequent catalyzation may require a pre-dip or catalyst conditioner to improve catalyst adsorption. The catalyst itself is usually an acidic solution of palladium and tin. Some systems use alkaline palladium solutions or colloidal suspensions of copper. Certain catalysts, which tend to agglomerate and form particles that can stick to the work and cause roughness, benefit from filtration.

After thorough rinsing, a post-catalyst or activation step may be used to remove supporting material from around the catalyst, thereby allowing it to operate more efficiently. Some processes incorporate this step in the electroless-copper bath.

Copper Deposition

Great tales of woe surround the electroless-copper bath. Plate-outs, lost tanks, and sleeping solutions are well-known and feared phenomena. Yet a few simple steps can be used to quickly diagnose the problem and return the bath to normal use.

In theory, the boards hit the solution and copper begins to deposit, quickly at first, then gradually slowing. After 20 to 30 minutes for a high-build process, the successfully plated boards go on their way. In the all-too-common reality, however, nothing happens when the boards are first immersed. Copper reluctantly forms, and at the end of the cycle the partially covered boards are rerun or scrapped. Why?

The reason for the apparently sleepy bath is that the catalyst does not cause the copper to deposit; it only causes the evolution of hydrogen, which is what actually starts copper deposition. The deposition process then causes more hydrogen evolution, which produces more copper, which generates more hydrogen, and so on. Some operations use a dummy load to arouse the bath to initial action. As the bath wakes up, the solution builds up a hydrogen concentration that makes it more active. To control this buildup, and to mix the solution and prevent it from weakening close to the boards, air is sparged through the bath. Larger volumes of air disperse more hydrogen, making the bath more stable (less active). Bubbling a smaller volume of air through diffusers achieves the same stabilizing effect, while generating less fumes. The first load of the day should be run with the air shut off or at very low volume, allowing hydrogen to quickly build up to a working level.

Electroless copper suppliers offer several additives for their electroless solutions. One of these is usually a stabilizer, which the supplier will be only too happy to sell to calm down an active bath. More air or less heat can usually do the same thing—at an appreciably lower cost. Running the bath cooler and using less chemical stabilizer tends to produce the side benefit of a denser and more adherent deposit.

Disasters

The plate-out

Everything is going well, but suddenly the lovely blue solution turns brown and emerging boards look as if they've been dipped in sand! Production stops. Operators scrape the tank and etch it clean. The boards are scrap. Irate customers are told of a two-day delay. The chemist mutters about having too many things to do, and your supplier says you should buy more stabilizer.

Electroless solutions are inherently unstable. They can get out of sync if the concentration of one component becomes too high. A small amount of copper can also do a great deal of damage. After all, the stuff is autocatalytic-one loose bit of copper becomes 50, then 5,000, and by then it's too late.

Continuously filtering the solution and using an autodoser will help avoid plate-out, but the best prevention is experience. Your chemist should be intimately familiar with the line. This person should know, for example, that some time after lunch, perhaps around 3 p.m. when the formaldehyde gets a bit high, the stabilizer pump should be turned off, the dosage reduced, or the air increased.

Voids

Nothing works! Boards are coming out of the line like crazy, and none of them is any good. The operators keep loading the line regardless, the chemist mumbles about how he's never trusted the process, and the supplier tells you to buy more catalyst.

A fast, inexpensive alternative exists. Fill a beaker with catalyst, using pretreatment first if required. Rinse. Use activator if required. Rinse. Then fill the beaker with copper solution and see how long it takes to develop a copper mirror. For a normal, well-functioning line, a bright, even mirror of copper should form on the inside of the beaker within one to three minutes. If not, the process of elimination can be used to quickly diagnose the problem. If the copper builds up rapidly, but is patchy, the catalyst stage isn't right or the conditioner in the cleaner isn't doing its job. If the copper builds up very slowly, the electroless bath is either overstabilized, low in one component, or too cold. (Don't always believe your thermostats; thermometers never lie.) The beaker drill is well worth practicing when the line is working properly.

Peeling copper

The copper is on the board, the backlights arc good, but the copper peels off with the tape! The operators keep on feeding the line, the chemist says he suspects there might be a problem, and the supplier offers to sell you more of everything.

Proper rinsing may be the most important part of the process. Without rinsing, nothing would work. If the catalyst is put down on an inadequately rinsed board, surface contamination provides an inadequate foundation for the copper deposit, which readily peels off. On the other hand, excessive rinsing, especially after the etch and catalyst, can cause tarnishing or partial removal of the catalyst, leading to voids. Air diffused through rinses after alkaline processes can improve plating quality and reduce plating costs.

Conclusion

There are many other problems that can strike down the unwitting electroless copper user—too many to detail here. As the general cure-all, I suggest experience. Hopefully, however, this article will assist by generating a little process faith and understanding. FAB

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