Electroless-Copper Alternatives

Complying with OSHA's new formaldehyde regulations.

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In May of this year, while one of our customers was installing our direct copper metallization process, his plant received unannounced visits by inspectors from the Fire Department, HazMat, AQMD, the County Health Department, and OSHA. They were responding to a neighboring plant's complaints that "a bad smell" had sent six of their employees to the hospital for a day of observation and treatment. Since our customer had not allowed solvents in his PCB fabrication plant since 1972, he wasn't surprised when the inspectors, failing to detect any foul odors in his plant, turned their attention to the complaining neighbor, an assembly house using chemical cleaners and conformal coatings. But the OSHA inspector delayed his departure when he noticed a drum of formaldehyde by the PCB fabricator's electroless-copper line.

The inspector informed our customer that on May 27, 1992, OSHA published an amended standard of occupational exposure to formaldehyde.[1] He said that Title 29, CFR Part 1910.1048 lowers the eight-hour time-weighed average permissible exposure in air from 1 ppm to 0.075 ppm. Because of the new permissible exposure limits, he explained, companies with formaldehyde on the premises must have had additional controls in place by June 26, 1993. Our customer said that while he was familiar with the amended regulations, he had already decided to switch to a non-formaldehyde process when that chemical had been reclassified from a suspected carcinogen to a known carcinogen. Although the inspector did not have analytical instruments with him, he told our customer that he would return to see if the changeover had been completed. If not, he would require formaldehyde-monitoring devices on all employees and other necesary safety precautions.

Alternative Processes

Many printed circuit board fabricators face similar scenarios as the process that has been at the heart of PCB production becomes more stringently regulated. Anticipating this, and seeking other benefits, chemical manufacturers have developed a number of alternative processes to achieve hole plateability without the use of formaldehyde.[2,3,4] One of the newer techniques exemplifies the process changes and benefits that printed circuit board manufacturers can expect as the 30-year-old electroless copper process is replaced.

The process, developed by Alpha, formerly Ardrox Inc. (La Mirada, CA), uses the STS tin-stabilized colloidal palladium dispersion to deposit a film of palladium parti-

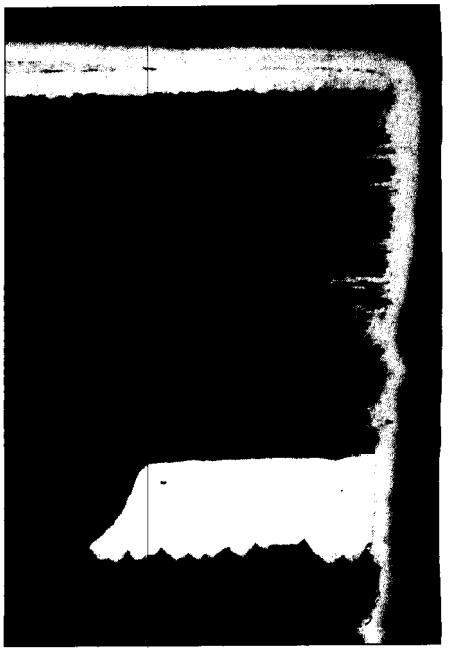

Figure 1. *Multilayer board* directly metallized and acid-copper plated.

cles on surfaces prior to electrolytic plating. Since the deposition takes place without the evolution of hydrogen gas, holes are more easily accessed and hole walls and vias more uniformly plated (Figure 1). With sufficient tank agitation, holes with aspect ratios of 18:1 have been successfully and consistently penetrated and plated. Reductions in tankage and processing time arc also achieved. The process typically eliminates six of the 20 or so tanks needed for the electroless-copper process, and its current users report an average 30% reduction in processing time.

Production Expedience

To make the changeover at the previously mentioned customer's facility, existing equipment was used with minor modifications involving heater placement and the installation of an indirect heat source far the activator step. Since surface contaminants impair any plating process, proper panel cleaning and desmearing must be achieved prior to the direct-metallization process.

To further enhance surface cleanliness, the first step in the process, a microetch solution, removes soils and permanganate residues from copper surfaces. A cleaner/conditioner step then solubilizes soils from the dielectric and changes its surface topography to increase the adherence of the subsequent palladium fiIm. A predip step follows the two surface preparation steps. This solution contains all the components of the activator solution, with the exception of the tin-palladium dispersion. Its use just prior to the activator, without the addition of an intervening rinse, extends the life of the activator by preventing the dilution of the essential components by rinse water drag-in.

The activator step contains the tin-stabilized palladium dispersion. Prior steps in the process ensure void-free hole coverage, and subsequent process steps either solidify the bond between the printed circuit board and the palladium deposition or remove the film from areas where it is not wanted, ***Fol***-lowing the activator, an accelerator step helps to insolubilize the deposit and converts residual stannous cations to stannic. A 10% sulfuric acid dip neutralizes alkaline residues and conditions surfaces for acid-copper plating. After the acid dip and following rinses, the boards

may be scrubbed to remove the activator film from copper surfaces, where the presence of palladium may produce cosmetically objectionable smudges and/or mottled areas.

In production facilities and in Alpha Metals' portable pilot line, several hundred thousand square feet of rigid and flex printed circuit boards have been successfully plated at high yields with this process. These boards include polyimide as well as epoxy substrates. Customer approval of the finished products has been positive, especially when they understand the environmental aspects of the change.

Although the cost of processing boards is approximately the same as that of conventional electroless plating, users confirm appreciable savings in waste disposal. The microetch and cleaner/conditioner will slowly become contaminated with small concentrations of copper, eventually requiring treatment in the system used for rinse waters. The most expensive solution in the process, the activator, never needs replacing. In contrast to the corresponding catalyst in electroless plating, which is routinely dumped and replaced once a year, the activator's stability is such that only replacements for drag-out losses are needed.

Conclusion

There is little doubt that direct plating will soon replace the electroless-copper process for PCB work. PCB manufacturers should familiarize themselves with the various direct-metallization technologies available and evolving environmental regulations. FAB

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