Formulating Solder Strippers for PWBs

by T. S. Krishna Ram

A board fabricator experiments with different solder stripper formulations.

Prim to either gold or nickel-gold plating of connectors, the electrodeposited solder is selectively stripped. The solder circuits and hole interiors are also stripped in the solder mask over bare copper (SMOBC) process. Various chemical stripping formulations have been used for this purpose, but one formulation in particular is suitable for industrial production. It includes an inhibitor to minimize the attack on the copper.

BACKGROUND

In PWB fabrication the metal resist that is stripped prior to plating consists of bright tin, tin-lead alloy, or tin-nickel alloy. These metals have very poor wear resistance and require relatively high voltages to break down the insulating oxide films that form on their surfaces. Further, bright tin deposits have a tendency to produce dendrites.

Before stripping, the circuit area above the connectors is masked with waterproof, chemical-resistant, polyester-based tape. Selective stripping is then done either by deplating (using the reverse current technique) or immersion in a chemical solution.

The major disadvantage of the reverse current technique is that it is a highly critical operation; a small carelessness can lead to high rejects in large-scale production.

The chemical immersion method, on the other hand, is relatively simple and has the following advantages:

- Easy to operate and control without having to use sophisticated equipment
- High rate of stripping
- Larger quantity of metal can be stripped in a given volume of chemical stripper
- Minimal attack on the base copper (which can be further reduced by the introduction of the proper inhibitor)
- Faster rate of operation reduces labor costs
- Usually works at room temperature (30 to 40°C).

With these points in mind, experiments were conducted to formulate an optimal stripper solution. The following compositions were tried:

- Acetic acid, H_2O_2[1]
- Nitric acid with urea[2]
- Nitric acid, hydrogen peroxide. and urea
- Fluoroboric acid and hydrogen peroxide with inhibitors.

THE EXPERIMENT

Before trying the different stripper solutions, the circuit portion above the connectors was masked with No. 9180 polyester tape (Ideal Tape Co., Lowell, MA) to prevent chemical attack on these areas. Then, precleaning steps were performed. The connector portion was degreased with trichloroethylcnc-acetone and given a pumice scrub. The area was then rinsed in water and finally immersed in a stripping solution.

The postcleaning and nickel-gold

plating steps were rinse in water, pumice scrub and rinse, dip in 10% $(NH_4)_2S_2O_8$, solution (microetch for 20 to 30 seconds) and rinse, dip in 10% H_2SO_4, for two to three minutes and rinse, nickel plate and rinse, passivation-removal dip and deionized (DI) water rinse, gold plate and DI water (drag out) rinse, and final rinse.

The experiments were conducted with 22-pin standard connector patterns (2 X 10 mm) plated with 15 microns of solder. The solder's thickness was measured by beta-ray backscatter using Microderm Model No. MD3 (Upa Technology Division, Veeco Instruments, Syosset, NY).

Of the various chemical strippers tried, most were unsatisfactory, either because they stripped very slowly, their attack on the base copper was too vigorous, or smut was formed. Further studies carried out on the two most promising formulas varied the concentration of their constituents.

The two modified formulas are described in Table 1. In the experimenters' opinions, Formula 1 is better than Formula 2, because it leaves a clear, bright copper surface. With Formula 2, a smut is formed that must be scrubbed off prior to plating. Therefore, further experiments were conducted with Formula 1 only.

Table 1. Optimal Formulations for Two Chemical Strippers.

Formula 1	
HBF_4 (sp gr 1.32)	500 ml
H_2O_2 (30°/0)	200 ml
DI water	300 ml
Temperature	room
Strip rate for 15 microns of solder	25 seconds
Formula 2	
HNO_3 (sp gr 1.3)	400 ml
H_2O_2 (30%)	200 ml
Urea	1 g/l
DI water	400 ml
Temperature	room
Strip rate for 15 microns of solder	10 seconds

ADDING AN INHIBITOR

To minimize the attack on copper, the following inhibitors were added to Formula 1:

- Triisopropanolamine (TIPA)
- Thiourea
- Sodium diethyl dithiocarbonate (SDEDTC)
- Tricthanolamine (TEA).

Table 2. Results of Different Inhibitors Used with formula 1.

Inhibitor	Concentration	I_{corr} microns amps/cm²	Corrosion Rate roil/year	mm/year
No inhibitor		225.80	102.30	2.60
Triisopropanolamine (TIPA)	6.8 g/l	118.28	53.60	1.36
Thiourea	10 g/l	25.09	11.37	0.29
Sodium diethyl dithiocarbonate (SDEDTC)	10 g/l	17.92	8.12	0.21
Triethanolamine (TEA)	10 mill	8.96	4.06	0.10

Using an electrochemistry system. Tafel plots were recorded in the standard corrosion cell to calculate the I_{corr} values, Copper disc electrodes with diameters of 6 mm were used. From the I_{corr} values, the corrosion rate was calculated using the following formula:

- I_{corr} is in microns amps per cm^2
- E.W. equals equivalent weight in grams.
- Density is in grams per cm^3.

From Table 2, the experimenters concluded that Formula 1 with a 10 ml per liter concentration of triethanolamine was the best solution. The solder was stripped at a faster rate, and there was negligible attack on the copper. In practice, Formula 1 continues to be a good choice. It dissolves 110 g of solder (60% tin and 40% lead) per liter of stripping solution.

ACKNOWLEDGEMENT

The author wishes to thank the management of Electronics Corp. of India Ltd., in particular J.V. Kanitkar, component group, for permission to publish this article,

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