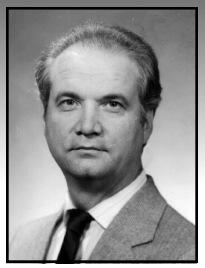

Advice & Counsel

Frank Altmayer, CEF, AESF Fellow • AESF Technical Director
Scientific Control Laboratories, Inc. • 3158 Kolin Avenue • Chicago, IL 60623-4889
E-mail: mfconsultant@msn.com

Training "Colombo"—Part XIII
Electroless Nickel Solutions & Processes

Dear Advice & Counsel,
My company uses outside sources for electroless nickel (EN) deposits over copper substrates used in an electronic application requiring that the EN coating be solderable without the use of any flux. Soldering is performed in a conveyorized furnace under nitrogen-hydrogen atmosphere, at a temperature range up to approximately 250° C. The purpose of the hydrogen is to reduce surface oxides, which inhibit solderability, while the nitrogen is an inert dilution gas to maintain the percent-hydrogen at preset levels. Three types of components are soldered onto the surface of the EN using no flux and "preforms" of solder. The solder preforms are die-cut and set onto the surface of the heat sink. The assembly then enters the heated zone of the furnace, where the temperature is ramped up in a controlled manner until the solder melts. Soldered components are tested for adhesive strength by application of a shear force to the soldered component base. Poor solder joint strength results in the soldered component being pushed off the electroless nickel surface.

We have been experiencing erratic results and would like any information on what we could have the vendor change to improve the solderabilty of the electroless nickel. The coating we are currently specifying is a mid-phos, 7–9 percent deposit.

Signed,
Nicole Noelectra

Dear Ms. Noelectra,
We discussed going to a lower phosphorus nickel, but that would require a specification change, so it is not a viable quick alternative. A lower phosphorus content electroless deposit would provide some benefit, however, because the long-term solderability of the deposit diminishes with increased phosphorus content.

Our investigation determined the following causes and remedies to the problem of solderability. The following list is provided, with the most important cause covered first, but the relative importance of the second and third must be established by further testing and evaluations.

Surface Condition of the EN Deposit

Plated parts were successfully soldered when parts were less than 24 hours old. The solderability of freshly deposited EN is reduced significantly by aging and/or the presence of surface impurities. As the electroless nickel ages, it reacts with oxygen in the air, forming nickel oxide. It can also react with other elements in the atmosphere, especially sulfur (from paper, or naturally present in the air) to form stable nickel compounds (nickel sulfide in the case of sulfur contamination). It is the presence or absence of dense oxides/sulfides that results in poor solderability.

The problem is aggravated by the presence of impurities in the EN deposit, resulting from poor filtration practice on the part of the plater and a general lack of control over the operating parameters of the electroless process, including the level of impurities present in the plating solution.

The maximum level of commonly encountered impurities must be maintained as follows:

Impurity	Maximum ppm
Lead	5
Cadmium	5
Iron	150
Aluminum	300
Palladium	3
Cr^{+3}	15
Cr^{+6}	3
NO_3	50
H_3PO_3	150

The soldering furnace employs hydrogen gas to reduce oxides from the surface of the electroless nickel prior to soldering. Solderability may be affected by the furnace conditions as follows:

1. The hydrogen you use is "dry," while humidified hydrogen is considered to be more effective in reducing oxides.
2. In your soldering operation, the hydrogen gas concentration is lowest, when it is most needed. The gas concentration is 26–31 percent, during the time when the solder first enters the furnace, up until it is theoretically at a "pasty" condition (prior to melting). Based on the temperature profile we were provided, once the solder has melted, the hydrogen gas concentration exceeds 50 percent. At this point, it is effectively not needed because the solder has already melted. If possible, re-program the soldering operation to have the higher hydrogen concentration *before* the solder melts.

It is our opinion that the furnace is fully capable of successfully soldering EN deposits that are relatively "fresh," but we suspect that any EN that has aged significantly—or has reacted with sulfur—does not solder well under these conditions.

Solder Quality

Our on-site investigation indicated that there is a significant variation in quality of the solder preforms. The surface of some of the dewetted solder turned a golden-orange in color, and it appeared that the degree of discoloration was directly related to the degree of dewetting observed. Furnace operators indicated that a change of preform solder reel often solved a soldering problem, indicating that a variation in solder preform quality may be related to the problem.

Our recommendations to achieve a high level of solderability in this manufacturing operation follow:

1. The electroless plating processes need to be modified and better controlled.
2. The packaging of plated parts needs to be revised so that the electroless nickel is not stored under humid or corrosive conditions.
3. The time between the plating of parts and the soldering of parts needs to be reduced as much as possible.
4. The solder preforms must be of consistent quality.
5. The soldering furnace may need to be optimized beyond the current conditions, if the above changes do not totally eliminate the problem.

More on electroless nickel troubleshooting next month. P&SF