Remedial Cleaning of the Mask From Hell

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This is a follow-up of the case study entitled 'The Mask from Hell.' That study showed the events leading up to a huge inventory of low-grade circuit boards with a solder mask that had absorbed high levels of water soluble flux during the HASL process. The characteristics of the mask and HASL process were such that the charged flux residues were heat sealed into the mask, defying conventional attempts at cleanliness measurements. Use of these contaminated bare boards resulted in consumer electronics products that would fail almost immediately and universally in burn-in testing.

Faced with the possibility of a costly scrapping of hundreds of thousands of boards, the manufacturer asked if some form of rescue cleaning could be performed to bring the boards back down to an acceptable level of chlorides. This would be a reasonable approach if the residues were primarily on the surface of the boards, and therefore cleanable with conventional practices. However, in this case, the residues had all been absorbed into the solder mask.

Various experiments were tried with batch cleaning and in-line cleaning, using a variety of saponifier / surfactants which we knew to be effective against chloride residues. Some of the initial laboratory tests were encouraging, but in retrospect, the initial tests were relatively low energy - room temperature solutions, static soaks, etc., and not necessarily representative of what might be experienced in production equipment.

When we did the rescue or remedial cleaning in a Westek III in-line aqueous cleaner, we found that the more we cleaned, the more we actually increased the amount of contamination detectable by ion chromatography. There was a corresponding failure rate in accelerated testing. It's not good when you clean something and it comes back dirtier than when you started. Increasing the temperature and the spray pressures, which would normally be used for increased cleaning power, only served to make the cleanliness levels worse.

We determined that the low-grade solder mask had so thermally degraded prior to the cleaning, that it had no chemical resistance left. The saponifier solution, with the mechanical energy of the spray jets, served to break down the mask further, allowing more flux to be extracted later. Because the mask was much like a sponge at this point, the surface cleaning could not reach the inner layers of the mask.

After exhausting all possibilities, we concluded that the contaminated bare boards could not be remedially cleaned, short of completely stripping the contaminated mask from the boards and redepositing the mask. While painful, the most cost-effective solution was to scrap the contaminated boards and build new boards

While this remedial cleaning research was taking place, we worked with the fabricator and assembler to determine if a move to a higher grade solder mask material would cure the problem. Using a "heated control", which was a board that passes through wave solder with no applied flux (dry), we found that a better mask, with good chemical and thermal resistance, solved the problem. We have been asked, "how do you know if it is a higher quality mask?" In our estimation, if a solder mask has been qualified to IPC-SM-840, then the solder mask has a minimum acceptable level of quality. Yes, a higher quality mask costs a little more, but imagine how much was lost scrapping several hundred thousand bare boards.