Controls and “Rinsing” for Hand Soldering in a Mixed-alloy Environment

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Contract manufacturers (CMs) must ensure their material controls are sufficient to produce both tin/lead and lead-free products concurrently, without the possibility of cross-contamination. Some of the expenses to manufacture both products at once are unavoidable. For example, a wave solder machine cannot be switched easily from tin/lead to lead-free without significant effort.

The concurrent processing of tin/lead and lead-free products requires that there are controls in place to prevent processing tin/lead assemblies in the lead-free wave solder machine, and vice versa. The question that remains is whether or not this type of control is needed in hand soldering operations, and in particular, soldering iron tips (Figure 1). An electronics assembly facility that has hand assembly and rework operations containing hand soldering or PCB rework stations requires a sizeable investment in new hand soldering tools if a fully segregated area for lead-free assembly were to be established. If the assembler creates a physical separation between lead-based and lead-free process areas, additional floor space with modifications would be required.

Figure 1. *Soldering Rinse Step 1: Flood the soldering iron tip previously used in a tin/lead soldering process with as much of the wire-core lead-free solder as it can hold before dripping off.*

Soldering Iron Tip Construction

In general, most soldering iron tips are similar in composition. The core usually is made from copper due to its high thermal conductivity. Iron or other harder metals are used to help maintain the shape, while simultaneously preventing copper dissolution (Figure 2). The sides of the tip usually have additional nickel plating, followed by chrome that prevents solder from wicking up away from the working area of the tip. Manufacturers then apply a coating of solder to the tip, which helps keep the tip’s surface wetted, while serving as a thermal bridge.

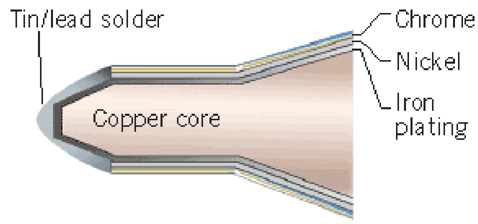

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Figure 2. *Soldering iron tip construction. Courtesy of OK International.*

With the anticipated rapid-plating failure of soldering tips in lead-free hand soldering due to more aggressive nature of the fluxes (among other things), there are a few changes tip manufacturers can implement to extend tip life. Soldering tip manufacturers can increase the iron-plating thickness, even with the aggressive high-tin content of lead-free solders. However, iron has a relatively poor thermal conductivity, which reduces thermal-transfer efficiency of the tip.

Solder and Intermetallics

Metallurgical properties of the solder and its tip determine which metals can be mixed into which alloys during the soldering process. The tin found in tin/lead and lead-free solders forms intermetallics with other metals. It is this formation of tin intermetallics that allows the solder to stick to the surface being soldered. Lead, on the other hand, rarely forms intermetallics, leaving the tin of the solder to mix and form alloys with other metals and intermetallics that may be difficult to remove. While remaining in the solution, lead does not form intermetallics or other molecules, thereby allowing the lead to be removed without the need for a chemical or abrasive process.

Solder Rinsing Techniques

By realizing what the soldering iron tips are composed of, and by understanding some of the metallurgy of tin and lead in solder, ways to remove lead from a soldering iron tip are better conceived. Because lead does not form any intermetallics, and tin dissolves the lead, the tin content of the lead-free solder dissolves the lead on the tip, allowing it to be removed through mechanically being “wiped” from the surface.

This concept is similar to using hot water to rinse soap from a car after it has been washed. The soap does not form a molecular bond with the surface of the car; therefore, the water dissolves the soap. This allows the water to rinse the soap off the car. In the case of soldering iron tips, this process can be used to rinse lead off of a hot soldering iron tip using the high-tin-content molten lead-free solder.

Evaluation

An evaluation of the weight-percentage levels of lead in a typical hand soldering process yielded interesting results. A soldering iron tip first was tinned with tin/lead solder, followed by a subsequent wipe on a moist sponge (Figure 3). After being cleaned, lead-free solder was added to the tip. The quantity of solder added to the tip was the maximum amount the tip could retain without having any solder drip off. A clean non-wettable surface was used to collect the solder. This entire process, which simulated the lead content in a solder joint where the tip had tin/lead solder wiped off on the sponge prior to soldering a lead-free connection, was completed several times until a sample was collected for analysis. By using inductively coupled plasma atomic emission spectrometry (ICP-AES), the weight percentage of lead in the sample was determined. The lead-free solder used in the test was analyzed using the same method, and the percentage of lead was 0.079%. Similarly, a post-wiped tip was analyzed, and the percentage of lead was 0.91% (Figure 4). A simple wipe (without rinsing), as demonstrated by this analysis, could reduce the lead content of the solder on the tip from 37% to less than 1%. While this is significant, the amount of lead in the solder sample from the tip was much greater than the amount of lead in the supplied lead-free solder

Figure 3. *Solder Rinse Step 2: Wipe the tip on the DI-water-soaked sponge. Repeat steps 1 and 2 three times.*

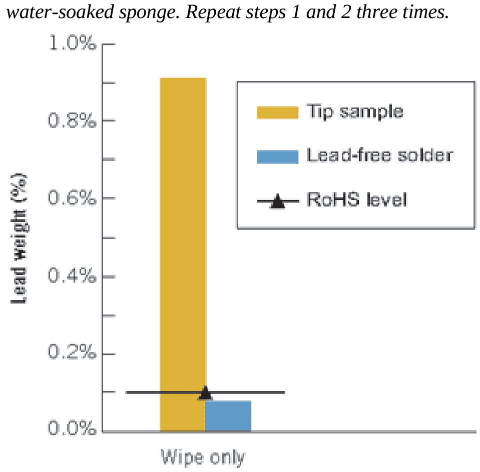

Figure 4. *Weight percentage of lead on soldering tip post-wiping, and initial lead-free solder.*

Data revealed that wiping the soldering iron tip on a moist sponge was not an adequate method to remove residual lead from the tip down to RoHS-compliant levels. This process also indicated that the tin in the lead-free solder was good at dissolving most of the remaining lead on the tip.

Post-wipe Rinse

The next step in the evaluation was to observe the effects of an additional application of lead-free solder to the tip (a rinse). For the second set of samples, the soldering iron tip was tinned with tin/lead solder. The tin/lead solder on the tip was then wiped off using a moist sponge. Next, lead-free solder was flooded onto the tip so that no more could be added without excess solder dripping. The solder that was on the tip was then wiped off onto a moist soldering station sponge. At this point, more lead-free solder was added to the tip. A sample of this lead-free solder was collected onto a clean, non-wettable surface. This process would simulate not only a tip wipe, but also a rinse using lead-free solder prior to a solder connection. Analysis of this sample revealed a significant reduction in the percentage of lead (0.34% lead by weight) (Figure 5). While the effects of the single-solder rinse reduced lead content, the decrease was not enough to meet RoHS requirements.

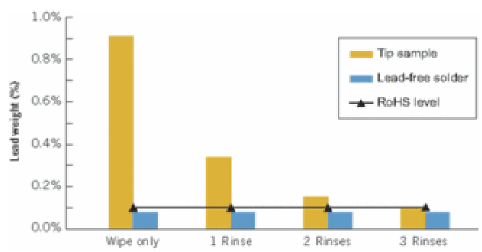

Figure 5. *Weight percentage of lead on soldering tip post-wipe and post-rinse.*

Second Rinse

For the next set of samples collected, the entire process was repeated, but instead two tip rinses were completed. Results revealed another reduction of lead content, down to 0.15% by weight. This double-rinse process reduced lead content more than half; however, this was still too high to meet RoHS requirements.

Third Rinse

A third rinse was included for the last collection. During this rinse, the lead content by weight on the tip was reduced to 0.10%, meeting RoHS requirements. This rinse reduced lead levels to within 0.021% of the original lead-free level. This demonstrates that at least three rinse cycles are required to use the same soldering tip for both alloy types without fear of cross contamination.

Conclusion

Results indicate that rinsing the soldering iron tip with lead-free solder gradually reduces lead-contamination levels to that of the original lead-free solder. Although this means a soldering iron with the same tip can be used for both tin/lead and lead-free soldering, it does not eliminate the need to tightly control materials and processes in a mixed-alloy hand soldering area. Whether a separate space is established for lead-free processing, or both tin/lead and lead-free soldering is done at the same workstation, it is essential that process controls are in place, and that all employees are trained thoroughly in the rinsing process.

REFERENCES

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