Hi-rel Soldering

Re-tinning Components for Hi-Rel Assembly

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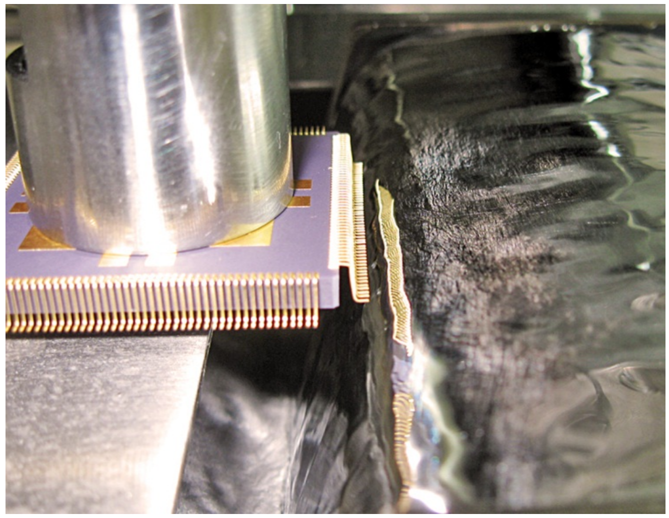
Lead tinning has experienced a surge in popularity recently for a number of reasons, even though the process has been in use for nearly 25 years. The original need arose when the military decided that plated finishes – which are not fused – were not suitable or acceptable for Hi-rel environments. The problem, at the time, was that plated finishes were found not to be robust enough to withstand oxidation encroachment to the base lead, and could result in a solder joint failure in the field. That process gradually diminished in necessity over the years, but now it has come back for that reason as well as for others.



So there are essentially five reasons for re-tinning:

- Convert Sn/Pb components to RoHS
- Refurbishing of "Legacy Components" - Removing the oxidized (plated) lead finish and replacing with a fused intermetalic Sn/Pb finish.
- Gold Embrittlement Mitigation: Removing the gold from the components leads by "solubilizing" in molten Sn/Pb solder.
- Tin Whisker Mitigation: Replacing the tin plating with fused alloy.
- Convert RoHS components to Sn/Pb

In the first instance, we remove or change the finish on a needed component, when that component is not available, off the shelf, with the correct or specified finish allow. For example, let's say I'm building a Hi-rel assembly that's put together using traditional lead-bearing Sn63 alloy. Unfortunately, one of the components that I need to use in that assembly is only available in a RoHS-compatible finish, in this case, electroplated tin. What do I do? If the component is plated with tin, shouldn't it be compatible with tin/lead solder? Not necessarily. The added volume of tin in the plating, however slight, will change the percentage of tin in the solder joint, creating a new alloy that may have undesirable characteristics, such as being more brittle.

In the second instance, we remove the Sn63 lead-bearing finish from legacy components so that they can be re-tinned using a RoHS – compatible alloy. In this case, the leads are dipped into a 'sacrificial' alloy pot to remove the old finish, and are then re-dipped into a fresh pot of 'virgin' alloy. Since RoHS took effect, there are fewer and fewer components available in stock with tin/lead lead finishes, so they must be hot solder dipped in a tin/lead bath to make them suitable for assembly in hi-rel products. Hot solder dipping, done properly, will 'wash' off the tin so that the leads can be properly re-plated with tin/lead.

Third reason is to 'scrub' the gold off component leads, gold that has been plated onto them initially to help them stand up to the rigors of the burn-in process. That gold must be removed, because it can cause gold embrittlement in the solder joint if it remains. Removal of gold is achieved by hot solder dipping to 'wash' the gold off, and then, again, re-dipping into pure alloy to apply the final solderable finish.

Fourth reason is mitigation of tin whiskers, something everyone seems rightfully concerned about these days, in the conversion to high tin content lead-free alloys. Even NASA has published papers that say, in effect, that the only reliable way to mitigate tin whiskers and prevent their growth is to dip the leads in molten alloy. This creates a 'fused' intermetallic finish that is unlike the non-fused electroplated finishes, which are a lot like a coating of sand – not fused or connected and prone to tin whisker development under certain conditions.

The fifth reason is a variation of the first, i.e., to take a modern component with a RoHS-compliant finish and re-tin it with SnPb alloy for use in RoHS-exempt Hi-rel assemblies.

System Requirements and Procedure

These are the 'whys' of re-tinning; the 'hows' are critical, however, to achieving success. There are two very fundamental requirements; first, that the process is achieved using a two-solder-pot system; one containing the 'sacrificial' alloy for scrubbing, and the second containing the 'virgin' new alloy needed to coat the leads. Secondly, for success in a production environment, and consistency, the process must be automated, with every process variable – dwell, temperature, depth, etc. – strictly regulated. This helps ensure that components will be processed in accordance with IPC/EIA JSTD-001 and ANSI-GEIA-STD-0006.

Using an automated lead tinning system, one pot absorbs the contamination, and its purity must be monitored, and it must be exchanged for a fresh pot when the level of gold or unwanted material reaches a certain saturation point. Then, a second or 'virgin' pot must be used to re-plate the leads with fresh and uncontaminated material.

The second requirement is a flowing, not a static, solder pot, since the flowing solder, particularly in the scrubbing pot, removes contaminated or scavenged material such as gold from close proximity to the leads, so that the contamination will not be pulled back to and deposited onto the component lead when the component is pulled out of the solder. It's also important to have some sort of agitation in the first, or scrubbing, pot as this actually helps the removal of gold or lead solder from the leads. This can easily be accomplished with mechanical manipulation of the device holding the component in the bath.

Re-tinning Through-Hole Components

The procedure for re-tinning through-hole components, from start to finish, involves the following steps:

- Incoming solderability test using a wetting balance tester;
- Careful handling and fixturing of the components;
- Processing the components in a robotic lead tinning system using a double dip process. The first dip is into a cleansing bath of molten alloy to remove the original coating, followed with a flux dip then a final immersion into a "clean" solder bath for a pure eutectic or RoHS finish.
- Post cleaning.
- Visual inspection.
- Final wetting balance test to assure best solderability.
- Lot report documenting the details of the process.

The use of nitrogen blanketing or inert atmosphere in the second, or finishing pot, is desirable because it promotes a lustrous finish, and mitigates dross formation, as well as the formation of icicles and bridging. It's very important that this entire process is automated. Reasons for this include the obvious desire for repeatability and consistency of results component to component, but also to take it out of the hands of the operator, to prevent damage to delicate fine pitch leads. It's much better to automate and thoroughly control the process precisely from start to finish. Dipping times for removal of plating, and for re-tinning average about 2 seconds for each row of leads. Also, flux is applied through a dipping process to ensure uniform application and thorough fluxing for proper wetting. One wants enough flux to achieve the objective without applying excess and creating a cleaning issue.

Thus, the process, from removal of the component from the tray, through fluxing, preheating, dipping, visual inspection, followed by post-cleaning and washing, drying, inspecting, and put back in the carrier that it came from, should be completely automated. Visual inspection mid-process is to ensure the absence of bridging, a real potential problem when tinning fine-pitch components such as QFPs. This is why the tinning process requires pre-heating, at a controlled temperature ramp to a desired set -point, especially important with ceramic components, prior to both the 'removal' dip and the 're-tinning' dip. The preheating also minimizes any potential for thermal shock or damage at the lead/body interface.

The automated lead tinning system employs two (2) dynamic N_2-inerted solder pots, a dynamic flat wave fluxing station, and a forced hot air pre-heat station. The pallet holder should be designed to accept a wide variety of component specific pallets, for versatility and minimal change over time. The system should be fitted with automated dross skimming to be performed just prior to component immersion (each time). Additionally, programmable routines such as "agitate in the solder" are key to helping remove the original coating; operators should also be able to specify and control withdrawal rate from the final solder bath to increase the solder thickness.

The system works in conjunction with pallets that hold the components in a known position through the process. Under program control, a pallet of components moves to the flux station where the component leads are immersed to a specific depth followed with preheating the component bodies, then to the first solder pot (scavenging pot) to remove the existing coating. The pallet returns to the flux station where the leads are once again fluxed then to the second solder pot for the final homogenous intermetallic coating.

QFP/SMT Re-tinning Process

The process for re-tinning QFP surface-mount leaded components is slightly different, as is the machine configuration, since bridging is a key concern in the process. For this reason, a unique tinning method using a specially-designed “Side Wave” solder nozzle that is heavily purged with nitrogen has proven highly effective. The side wave process uses the natural cascade of the solder to scrub the old plating off while wicking away excess solder during the extraction of the leads, leaving the leaded array bridge-free. This process has demonstrated to be quite robust.

System requirements include the application of “Look up” Cameras for alignment and post solder inspection for bridging; a dynamic “Side Wave” fluxing station; a forced hot air pre-heat and/or drying station; a scavenging solder pot with “Side Wave” nozzle to remove original finishes, as mentioned above, and a final dip solder pot, again with the “Side Wave” nozzle for final coating.

The sequence of the process is as follows:

1. The populated component JEDEC tray is loaded into the location nest. The door (interlocked for safety) is closed and the cycle is initiated.
2. The pickup head moves to the 1st position where the top side camera looks down over the component. The vision algorithm determines the center of the component body. The XY coordinates are automatically adjusted to zero the vacuum pickup head (VPH) center to the component body. The VPH moves down and acquires the component raising it away from the nest of the tray.
3. The component centering is verified by the “look up” camera.
4. The component leads are fluxed on all sides.
5. The preheater raises the component body temperature as necessary.
6. The component leads are immersed in the solder wave to dissolve and remove initial coating.
7. The component leads are fluxed on all sides.
8. The component leads are immersed in the solder wave for the final alloy coating.
9. Following the final solder dip and prior to cleaning the component, leads are checked for bridging. If any bridges are detected, the component may be reworked or rejected.
10. The component is immersed into the cleaning solution and agitated in a scrubbing action to removing flux residue.
11. The component is immersed in a H_2O rinse station to remove any remaining residue.
12. The component is dried.
13. The accepted component is returned to the same nest from which it came. The next component is acquired and processed and so on until all components in the tray are processed.

Conclusion

Removing gold plating, replacing RoHS finish with Pb, refurbishing legacy components and tin whisker mitigation are the major reasons to hot solder dip component leads. Re-tinning of through-hole and SMT/QFP components is a robust and reliable automated process whereby component leads (or terminations) can be refurbished in preparation for re-qualification to HiRel standards, and helps ensure that components will be processed in accordance with IPC/EIA JSTD-001 and ANSI-GEIA-STD-0006.

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