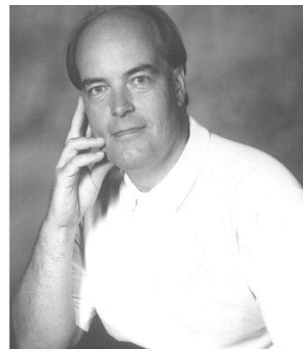
Disappearing solder with a lead-free process

Bob Willis



A number of people have asked the question recently, "Why do we see changing volumes in our lead-free solder joints?" Although lead-free materials do have a different density they are actually talking about the loss of solder to the component terminations during reflow.

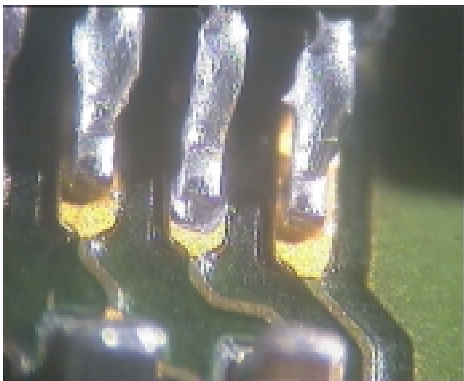
During lead-free introduction it is common, but not ideal, to use tin-lead coated component termination either because nothing else is available or they have been supplied without warning. Using a tin/lead terminations with a lead-free paste has been shown in some studies to have an impact on joint reliability and also cause secondary reflow on wave soldering resulting in lifted leads.

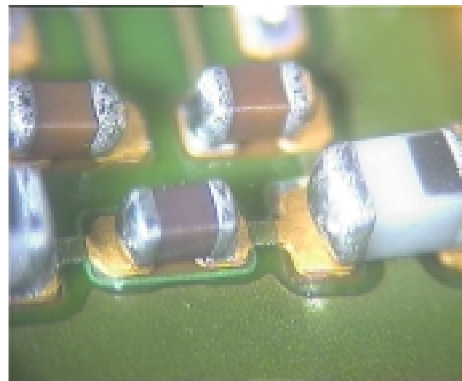
With a lead-free process solder paste is printed on to the surface of the pads, most commonly 0.006" of paste is used. Ideally one of the alternative lead-free printed board finishes like gold, tin, silver or copper OSP is specified. Lead-free solder levelled alternative like tin/copper/nickel may also be considered to replace tin/lead and is by far the most solderable coating depending of course on thickness. Component terminations are then automatically placed into the surface of the paste, the board is then passes for reflow in the normal way. During reflow the board passes through convection or vapour phase soldering (VPS) process reaching and exceeding a normal reflow temperature of 210-220°C used for tin/lead assembly. In this situation if the component terminations are tin/lead plated or dipped they will move into a liquid state and are very wettable, probably more so than most alternative PCB finishes and the alternative component termination plating like tin and palladium.

Example of tin/lead "Wicking" in VPS originally featured in the Texas Instruments Surface Mount Hands-On Workshop run by the author in Bedford during 1980's. This resulted was an open intermittent joint.

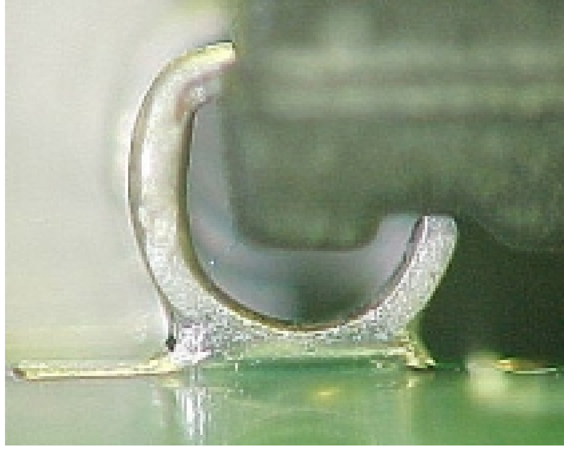
When the lead-free-solder paste reaches reflow temperature at 217-220ºC the solder is far more likely to wet to the component termination particularly on leaded parts like SOIC, QFP or PLCC. The board assembly will continue to rise to 235-245ºC and held until all the terminations are above reflow for a minimum of 30 seconds. In the case of parts with leads there is a large surface area to wet. The result is "**Wicking**" a process defect which can occur during normal tin/lead processes when the solderability of the PCB is poor and the component very solderable. In the passed it was very likely to occur with convection and IR ovens with mainly top heating and limited bottom heating. It could also occur with mesh belt systems as the belt could hold the board temperature down allowing the component termination temperature to rise much faster. VPS originally exhibited this type of defect more commonly on batch vapour phase systems with no or poor preheat. In this case the lead terminations would reach soldering temperature much more quickly than the printed board.

Example of tin/lead paste "Wicking" on copper OSP board finish after reflow. This was due to incorrect PCB cleaning which stripped the OSP surface protecting from the pads.



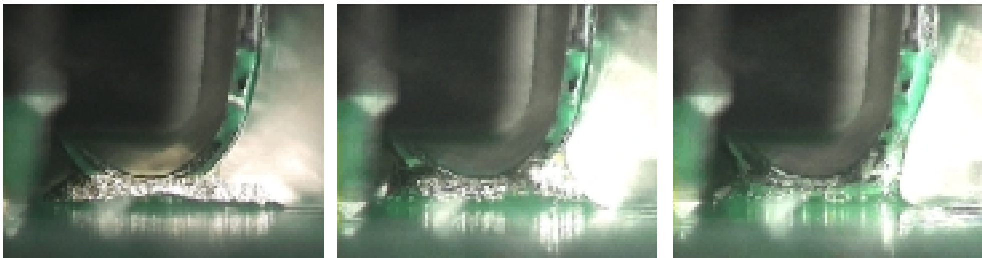


Examples of "Wicking" on gold pads on a pocket pager application with tin/lead paste when the solderability of the pads was poor. The stencil printer operator, incorrectly, always got the blame for limited paste, a good reason for sample inspection and PPM Monitoring go to www.ppm-monitoring.com



Example of satisfactory lead-free joint but the increased volume of solder can be seen on the surface of the tin/lead pin away from the joint area.

In the case of lead-free reflow with tin/lead component terminations the wicking process is practically the same. It can lead to opens but equally it can results in the reported disappearing solder contributing to the component coating and not joint formation. Although many people will not have seen this type of defect before it has been encountered and fairly well understood. It's the lead-free aspect that may catch people out during manufacture and final inspection.



Three images taken from the author's video showing tin/silver/copper paste reflowing with tin/lead component terminations exhibiting the wicking effect. The video is being featured in the Alpha Metals/Metcal Lead Free Seminars around Europe

Bob Willis is a process engineer working in the electronics industry, providing training, consultancy and process failure analysis on site for companies. Bob offers workshops on lead-free on site for customers, he has run lead-free production lines at exhibitions and also provides seminar and workshops worldwide. Bob will be running lead-free workshops for IPC & JEDEC in Germany and SMTA in US this year. For further information on lead-free training workshops, training materials and lead-free process support visit www.leadfreesoldering.com

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