Clive Ashmore

Will Your Printing Process Be Affected by Pb-Free?

Paste properties of lead-free solder alloys differ considerably from tin-lead.

As the industry prepares for the shift to lead-free manufacturing, numerous workshops, conferences and technical sessions are addressing the subject. Surprisingly, the majority of these so-called educational courses leave out detailed discussion of the impact of lead-free on the screen printing process, suggesting that pre-placement will not be affected. Not so! In fact, the research I've conducted shows quite the opposite.

The printing process (simplified, the two sub-processes of aperture filling and aperture release) is well documented for today's lead-rich materials. We understand how materials will react with different stencil types and various printing methods.

Since lead-free solder alloys change paste properties considerably and these materials are much less mature than lead-rich pastes, the printing process becomes very different vs. that of tin-lead material printing. Lead-free pastes generally have higher viscosity levels and a tendency to stick to stencil aperture walls, so previously well-defined tin-lead paste release characteristics are completely turned on their head when it comes to this new class of materials.

To further understand the mass imaging of lead-free pastes, our company designed two different research studies (with more underway) to evaluate the impact of squeegees vs. enclosed print heads and the effect of stencil material and fabrication method on lead-free printing.

The first study examined lead-free paste application using traditional squeegees vs. that of enclosed print heads, along with other factors such as print speed, paste pressure, aperture geometry and separation speed.

Our research studied Sn95.5Ag3.8Cu0.7, Sn96.5 Ag3.0Cu0.5, Sn96.5Ag3.0Cu0.5 and Sn63Pb37. We concluded that enclosed print head technology is compatible with all lead-free materials used in the study. In fact, our findings reveal that enclosed head technology results in increased lead-free print process capability as opposed to that of standard squeegee printing. This effect occurs because the downward pressure mechanism of the enclosed head is more capable of filling the aperture, thus ensuring the material is fully adhered to the land. Therefore, during the separation process, the lead-free material has more adhesion to the land than to the aperture walls and paste release is significantly enhanced.

Numerous other production benefits are realized from using enclosed head technology, not the least of which is reduced paste wastage. Because lead-free pastes are considerably more expensive than lead-based materials, the enclosed head also provides substantial cost savings.

Next, we set out to determine if stencil material and production method would have an impact on lead-free printing. For the study, we evaluated seven different stencils: three standard laser-cut stainless steel stencils with the variables being laser machine type used and local manufacturing procedures; a hybrid stencil produced by laser-cutting an electroform nickel blank; a standard electroform stencil; a laser-cut Kapton polyamide stencil; and a laser-cut, high-nickel-content stainless steel stencil.

The results are interesting: the three laser-cut stainless steel stencils produced dissimilar results, which proves that the stencil manufacturing process and production methods have a major impact on the characteristics of the print process. Ultimately, the study revealed that the electroformed nickel material performs best with lead-free pastes, with the laser-cut nickel stencil coming in as a close second, suggesting that using nickel as a base metal seems to result in a more robust and capable process. The research shows that stencil technology, stencil material and fabrication method have a tremendous effect on lead-free materials.

Last, but certainly not least, is the element of printing machine accuracy. Lead-rich pastes self align when reflowed and will correct for misaligned deposits. Lead-free pastes, on the other hand, tend to exhibit lower wetting forces during reflow and are less likely to self align. Therefore, the wet process accuracy (as opposed to dry alignment accuracy) and repeatability of the printing system factor greatly in successful lead-free printing. With lead-free materials, if deposits are misaligned during the print process, it is more likely that these may cause end-of-the-line defects.

Once you have taken all the classes and understand how to optimize the reflow process, change wave solder pots and rework lead-free solder joints, return to the beginning of the process and study the effect of lead-free on screen printing. ■

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