RoHS: One Year Later

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The industry’s conversion from leaded (eutectic) to lead-free has been slow. The industry perception prior to July 2006 was a virtual overnight switch to lead-free. However, today many OEMs still have a “don’t care, wait and see attitude” since they’re either RoHS-exempt at this time or don’t sell into Europe.

Others are at the decision-making stage. They’re wondering how far they can stretch leaded products before yielding to extra lead-free dollar outlays. Most major chipmakers and component manufacturers have complied with RoHS, although in some cases proper labeling is still missing.

Nexlogic Technologies, a mid-size EMS provider, can be used as an example to point up this RoHS compliance sluggishness. Our target was to transform 50 percent of our projects to lead-free this year. At the start of RoHS compliance, we had five to 10 percent of our projects lead-free. Subsequently, that number rose to 40 percent, but the 50 percent mark has not been reached as of this writing.

Slow industry response can be partly attributed to the European Union (EU) and associated agencies. They have not been strict about enforcing RoHS compliance. This is not to say the EU isn’t being diligent and companies aren’t complying. Rather, stringent rules haven’t been implemented and enforced, yet. It appears the EU has intentionally taken this approach to allow OEMs, EMS providers, and CMs more breathing room.

Industry Coming Together

EMS providers and OEMs continue facing and resolving lead-free design, fabrication, and assembly issues. These problems are bringing companies closer together to discuss and resolve them.

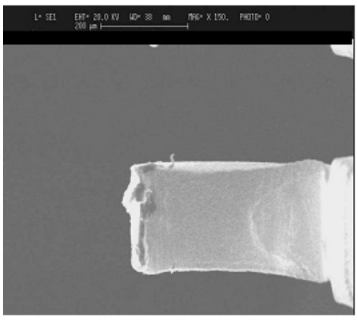
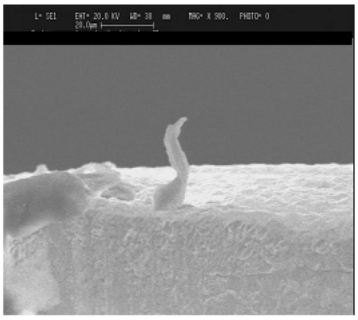

Fig. 1— Tin whiskers are electrically conductive crystalline structures that can cause short circuits.

Take for example the tin whisker problem, which is not new, but is aggravated in lead-free applications. Tin whiskers are electrically conductive crystalline structures of tin. Sometimes they grow from surfaces using tin as a final finish, Fig. 1. Lead-free alloys are composed of tin, silver, and copper. The lack of adequate lead content and greater amount of tin in this alloy triggers tin whisker growth. Tin whiskers can grow to lengths of several millimeters up to 10 mm. Electronic system failures are often attributed to short circuits caused by tin whiskers that bridge closely-spaced circuit elements.
One solution is tin-plating the copper in lead-free products at 150°C for 24 hours to reduce the potential of creating tin whiskers. Solutions like this are emerging from consortiums and forums dedicated to discussing and resolving lead-free issues. But achieving solutions is slow due to the complex nature of these issues.

PCB surface finishes and the correct solder paste represent another problematic area. Lead-free assembly requires finishes such as electro-less nickel immersion gold (ENIG), immersion silver, organic solderability protectants (OSP) and lead free hot air solder leveling (HASL), Fig. 2.

Different Board Finishes Compared

	HASL	OSP	ENIG	Tin	Silver
Flatness	NO	YES	YES	YES	YES
Solder joint	Cn-Sn	Cn-Sn	Ni-Sn	Cn-Sn	Cn-Sn
Wirebond	NO	NO	Al	NO	Au, Al
Cost	$	0.7 X $	3 X $	0.8 X $	1.5 X $
Reflows	6	2	6	2 to 3	6
Shelf Life	18 Months	6 months	24 months	6 months	12 months

Fig. 2 - Different surface finishes are used for lead-free PCBs, each with its own trade-offs and limitations.

Lead Free surface finishes are critical because their conductivity is considerably higher compared to the tin-lead variety used for eutectic PCBs. These finishes withstand higher reflow temperature cycles. There is also less probability of the pads peeling away from the board surface when exposed multiple times to higher temperature cycles.

The issue deals with which one to use due to trade-offs and limitations. HASL has a shelf life of about 18 months; OSP has only six months. Immersion silver has a shelf life ranging from 12 to 16 months, while ENIG is the most durable at 24 months. OSP cannot undergo more than two or three reflow cycles. If more rework is required, then the SMT pads on the OSP finish begin peeling off. OSP, therefore is not the best finish when multiple rework cycles are involved. But immersion silver or gold can undergo six to eight reflow cycles. Also, they have a flatter surface finish, which is more conducive to a a perfect assembly than a HASL finish, specially for fine pitch devices and BGA’s and CSP’s.

As for solder pastes, alloy selection has been a major consideration for assuring solder joint quality, reliability and production yields. Most EMS providers have chosen tin-silver-copper alloys (SAC) for leaded solder replacement. Two popular ones are SAC305 and SAC307 which are slightly different in alloy compositions. However, SAC305 or Sn96.5 Ag3.0 Cu0.5 with a melting range of 217°C to 220°C has been the alloy most EMS providers use due to a higher degree of solderability and flux wetting.

Other problematic areas being resolved are shrink holes and Black Pad. A shrink hole is an anomaly caused by a crack in a solder joint using SAC305 or 307 alloy. Costly rework is required when it occurs. Black Pad is a defect mostly occurring on ENIG surface finish boards. It is a solder joint separation formed on the surface of the electro-less nickel underplate. It is caused by excessive phosphorous in the electro-less nickel. Good thing is that it is an anomaly and not an everyday occurrence.

Hybrid PCBs populated with lead-free and eutectic components continue to sporadically pose issues. Aside from surface finish issues, RoHS compliance calls for special attention to PCB design so that assembly is flawlessly performed. This includes careful component selection and placement, choosing the correct solder pastes and also defining the assembly process to ensure that the hybrid assembly is performed smoothly. Depending on the number of lead free components, an EMS provider can define the whole assembly process as a leaded process whereby the lead free components are added at a later stage or vise versa.

Logistics Issues

However, there are costly and time delay problems CMs and EMS providers face at the operational level. On the one hand, mis-labeling or non-labeling of lead-free components is perhaps the biggest and costliest problem. On the other hand, many new and different symbols signifying lead-free products have emerged worldwide since July 1, 2006. Mis-labeling or non-labeling leads to erroneously mixing lead-free with eutectic components and applying incorrect eutectic assembly procedures. An overabundance of worldwide symbols demands additional resources to sift through the maze of complicated, confusing, and ambiguous symbols and labels.

Lastly, China RoHS officially raised its head earlier this year. It appears to be more demanding than the EU's version. In effect, it's a current distraction from fully concentrating on the EU's RoHS compliance.

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