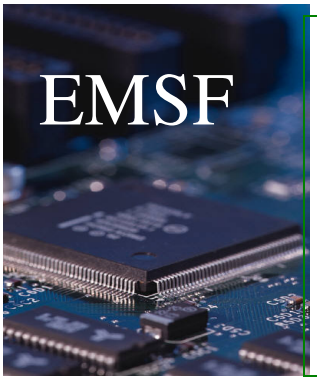


EMS Forum
on Lead-Free PCB Assembly

Guidelines for Lead-free Solder Alloys for Wave Solder and Pin-Through-Hole Rework

Rev. 1.0 (March. 2008)

Background

The electronic manufacturing industry and EMSF members continue to believe that the Sn-(3-4%) Ag-(0.5-0.7%) Cu alloy composition range (commonly abbreviated as SAC305/405 alloys) will be the most widely used alloys for SMT solder paste in the near future. However, there is an increased and accelerated interest in several different tin-copper (Sn-Cu) based alloys (hereafter referred as alternative alloys) with additions of elements such as silver (Ag: 0-1%) Ni, Ge, Co, Sb, Bi for lead-free wave soldering based on technical and commercial reasons. This reduction of silver content (as compared to SAC305/405) has significant impacts in a high solder volume consumption area such as wave soldering where the limited global supply of silver is a greater concern as compared to surface mount reflow paste. While recognizing that the development of newer alloys is necessary for scientific and commercial progress, the EMS forum would like to raise and highlight the concerns with the proliferation of lead-free wave and PTH rework solder alloys into main stream production.

- There is currently limited consortia and industry effort being conducted to understand the performance benefits of all these alternative alloys relative to the SAC305/405 solder alloy and the baseline tin-lead solder alloy for wave soldering and PTH wave rework.

- Cross-contamination control of the lead-free wave pot with tin-lead solder and vice-versa is an important consideration for sites manufacturing different types of products. The situation becomes much more complicated when multiple lead-free wave soldering alloys co-exist. The move to standardize the lead-free wave solder alloy will help reduce this logistical complication.

- Different alternative alloys with or without elemental additives have shown good processing and reliability properties specific to certain product categories. However, conflicting data is emerging on which specific additives provide the stated benefits (i.e. reduced copper dissolution). This proliferation of multiple alloys may delay the introduction of lead free products for some manufacturers as more qualification and requalification data will be necessary for each new alloy that is introduced, especially in the absence of any industry supported methodology for evaluation and qualification of new alloys.

- A manufacturing site having SnPb, SAC305 and one or more of the alternative alloys will likely have solder bars made of several different alloys. Although a few leading solder alloy manufacturers have introduced different shapes of solder bar for tin-lead and SAC305, they are introducing these alternative alloys in the same shape as the SAC305 solder bar. This will cause significant logistical issues for manufacturers and may increase the risk of cross contamination. Unlike solder paste jars, each of which has a unique label, there is no universal way to control the use of lead-free solder bars unless there is a change in shape and size of the solder bar.

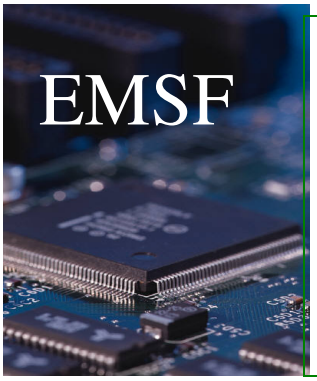
- Industry standards such as IPC J-STD-001 do not yet have contamination limits for solder used in wave pots for SAC305/405 solder alloys and alternative alloys, although J-STD-002C has recently indicated impurity limits for SnAgCu alloys for solderability testing but does not cover the alternative alloys. This proliferation of multiple alloys will cause delay in the introduction of contamination limits for IPC J-STD-001.

These and other factors are negatively affecting the industry as the appropriate tools are not in place to assess and monitor lead free wave and repair alloys. The EMS Forum is providing the following list as a “call to action” for the industry and seeks interested parties to help address these issues in an expedient manner.

End Users/Solder Manufacturers/ Standards Organizations (e.g. IPC/JEITA)

- Develop a standardized industry accepted methodology to assess the overall process and technical impact of the new alloys.

- When evaluating the alternative alloys, the assembly performance (including copper dissolution) should be equal to or better than that of SAC305/405 in primary wave (i.e. Hole-fill). Any changes (such as yield loss resulting in increased rework) in overall quality performance should be carefully documented for reference.



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- Organizations currently evaluating or considering evaluation of alternative alloys should include evaluations for both 1st pass wave and rework as well as recommendations on contamination limits backed by process and reliability data. It is preferred that such alloys are either patent free/widely cross licensed and endorsed by industry groups and consortia such as JEITA, INEMI, IPC, HDPUG or the manufacturers actively cross license these alloys so that they are readily available from multiple sources.

- The recently updated Telecordia GR-78 standard provides some relief on lead-free wave solder hole-fill requirements. A proposed Telecom addendum to IPC-610D is also in development concentrating on wave hole-fill requirements. However these are primarily based on the understanding of the characteristics of SAC305/SAC405 alloys and may have to be revised with the adoption of the alternative based alloys with higher melting temperatures.

Standards Organizations (e.g. JEDEC)

- It is to be noted that the alternative alloys have a melting temperature which is about 10°C higher than that of the SAC305/SAC405 solder alloys (227°C versus 217°C). Correspondingly higher wave pot and PTH rework soldering temperatures may be required especially for thicker boards to provide acceptable hole-fill, which may be constrained by the maximum temperature rating for components and boards.

- There are efforts underway to raise the maximum temperature rating for the lead-free wave soldered components in standards such as JEDEC JESD22-B106 (Resistance to soldering temperatures for Through Hole Mounted Devices). The temperature ratings may have to be further raised in consideration of the potentially increased solder pot temperature.

Standards Organizations (egIPC/SPVC/JEITA)

- The EMSF members would like to encourage industry standards organizations and consortia to work towards a standardized shape and size for each solder alloy. The shape should be significantly different from that of a tin-lead solder bar and the size of any lead-free solder alloy bar (including alternative alloys) should be smaller in size than the existing tin-lead solder bar. This strategy should be consistent across all solder bar manufacturing sites from a single supplier.

- All soldering materials should have the outer packaging boxes and inner package material marked with some form of traceable information indicating the composition of the alloy. This marking should also appear on the solder bars where applicable. An example of lead-free markings for solder material would be in the form of 'e' codes is available in IPC JEDEC J-STD-609. Green outer packaging and inner packaging material is preferred, at a minimum with Green text. All soldering materials should have new supplier P/N's assigned. Suffix or prefix additions to existing P/N structures are acceptable.

- Materials datasheets should clearly indicate the solder composition compliant to IPC-J-STD- 006 requirements, solder temperature melting point/range, and recommended solder profile limits. Inclusion of elemental additions that fall below the threshold required by IPC-J-STD-006 standard but may significantly affect the performance of the alloys, is strongly encouraged. A master "Certificate of RoHS Compliance" per guidelines of the IPC-J-STD-006 (Latest Revision) should be generated and submitted per lot.

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