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RECOMMENDATIONS FOR MANAGING Pb-FREE ALLOY ALTERNATIVES

Background

Pb-free processing is in its infancy, and, as a result, the electronics industry has much to learn. There are many questions yet to be answered regarding processing parameters, reliability and performance. It is inevitable and desirable that industry will continue to innovate, adjusting processes and materials (including solder formulations, fluxes, etc.) as our experience increases and we become more familiar with Pb-free assembly solutions.

One of the areas still evolving is alloy formulations. SAC 305/405 have been the most commonly used alloys to date. However, these alloys do not meet all of industry's needs for all applications. There are, for example, concerns about the use of SAC 305/405 for wave soldering, selective soldering, hand soldering and rework. The cost of these alloys (due to high silver content) can also be an issue in some applications. Another primary factor in the move away from SAC 305/405 is the need to improve mechanical shock survival (e.g., drop test), driven by the consumer electronics segment.

As a result of these reliability and performance concerns, solder suppliers along with their OEM and EMS customers are attempting to find better solutions to the electronics industry's need for a reliable, user-friendly and cost-effective Pb-free solder. Initial focus of these alternatives has been on BGA sphere composition and on wave/selective solder applications.

Challenges of Managing Multiple Alloys

The increased number of Pb-free alloys poses challenges in both manufacturing as well as product performance. These include:

- Reduced silver content can increase the melting point of the solder by as much as 10°C.
- Mixing of alloys on the same assembly (which is inevitable with sourcing BGAs from multiple component suppliers) can lead to improperly assembled components, impacting yield as well as product reliability.
- Solders with higher melting points can pose risks to PCB and component integrity (due to higher processing temperatures).
- Increased permutations of BGA sphere metallurgy, solder paste, and surface finishes is occurring much faster than industry can understand the impact to product performance and long-term reliability for mission critical applications.
- Mixing of wave solder with SMT and rework alloys is a potential problem when different alloys are used.

- Change in alloy composition with time in the pot may impact processability and reliability.
- Each new alloy must be characterized and manufacturers must qualify specific alloys for specific applications (including the impact to product reliability), which is a time-consuming and costly process.

Recommendations

iNEMI members are recommending several courses of action to help manufacturers manage the use of multiple solder alloys, as outlined below.

1) Drive convergence of Pb-free alloys

Help industry move toward convergence on a minimal number of alloys that will satisfy most application requirements within the electronics industry.

2) Develop an assessment methodology

We support the EMS Forum's call to develop an industry-standard methodology to assess the overall process and technical impact of new alloys. This methodology should meet the common needs of most applications. iNEMI's recently organized Pb-Free Alloy Alternatives Project is addressing the need for such a methodology. The project team, led by Greg Henshall (Hewlett-Packard) and Stephen Tisdale (Intel Corporation), is initially focusing on metrology of BGA solder joints. They are identifying knowledge gaps and establishing a common methodology for characterizing alternate alloys.

3) Establish performance guidelines

As stated in the recently published EMS Forum (EMSF) guidelines, when considering the use of alternative alloys, manufacturing considerations must be understood. Assembly performance (e.g., copper dissolution, impact on yield) as well as rework performance should be taken into account.

4) Update standards

As identified by the EMSF guidelines, standards must be brought up to date as changes in alloy formulations and related manufacturing process parameters evolve. iNEMI strongly supports this work and we encourage our project teams to interface directly with the relevant IPC/JEDEC committees. Such efforts have begun within the Pb-Free Alloy Alternatives Project.

5) Identify and differentiate alloys

iNEMI endorses the practice of unique markings on, and/or shapes of, solder bars to help minimize manufacturing errors in environments dealing with multiple alloy formulations. This is recommended by EMSF and is consistent with our previous call for unique part numbers for BGA ball metallurgies with significantly differing compositions that can impact manufacturing process parameters.

iNEMI Initiatives

In addition to the Pb-Free Alloy Alternatives Project (mentioned previously), the iNEMI Wave Soldering Project (led by Denis Barbini, Vitronics Soltec) is addressing the performance and reliability of Pb-free wave solder and selective solder solutions. Another iNEMI project — Pb-Free Rework Optimization (headed by Jasbir Bath, Flextronics International) — is characterizing and comparing Pb-free rework solutions for both surface mount and through-hole applications. We believe that the work of these two projects will help to further close the remaining knowledge gaps in industry's understanding of lead-free electronics. (See references for further details.) Other iNEMI initiatives addressing Pb-free technology include:

- Pb-Free Early Failure
- Pb-Free Component & Board Finish Reliability
- High-Reliability RoHS Task Force
- Tin Whisker Project, Phase II
- Pb-Free Nano-Solder

iNEMI member companies supporting the recommendations in this document include:

Agilent Technology
Celestica, Inc.
Cisco
Delphi Electronics & Safety
Flextronics International
Hewlett-Packard
Intel Corporation
Jabil Circuit
Motorola
Plexus Corp.
Sanmina-SCI
Sun Microsystems
Texas Instruments

References

"Guidelines for Lead-free Solder Alloys for Wave Solder and Pin-Through-Hole Rework (Rev. 1.0, March 2008)", EMS Forum on Lead-Free PCB Assembly
http://thor.inemi.org/webdownload/projects/ba/Pb-Free_Alloys/EMSF_Guidelines.pdf

iNEMI Pb-Free Alloy Alternatives Project
http://www.inemi.org/cms/projects/ba/Pb-Free_Alloys.html

iNEMI Pb-Free Wave Soldering Project
http://www.inemi.org/cms/projects/ese/LF_wave_solder.html

iNEMI Pb-Free Rework Optimization Project
http://www.inemi.org/cms/projects/ese/lead-free_rework_optimization.html