calce
Center for Advanced Life
Cycle Engineering

Long-term Reliability of Mixed (Pb-free Parts/SnPb Paste) Soldered Assemblies Study

Objective:
To provide participants with a critical assessment of the reliability of solder joints formed with lead-free parts and Pb-based solder. This is particularly a concern for companies that are attempting to maintain Pb-based solder.

Motivation:
While a large segment of electronic equipment manufacturers have converted to Pb-free parts and processes to meet, government regulations and market demands, a smaller set of manufacturers, particularly those in the high performance and reliability segments, are working to maintain Pb-based materials and processes. As the supply of Pb-based parts is reduced, manufacturers seeking to maintain Pb-based processes are faced with the decision of reprocessing Pb-free parts or using the parts as received.

For manufacturers and users of mixed (Pb-free parts/SnPb paste), reliability is a chief concern. Limited studies have identified potential issues with mixing Pb-free parts with the SnPb assembly process. Issues include poor reliability of SAC BGA solder balls due to incomplete mixing of SnPb into the final as solder microstructure. In addition, there has been expressed concern with tin bismuth (SnBi) finished parts due to the potential formation of low temperature ternary alloys of bismuth (Bi) with the SnPb solder paste resulting in compromised reliability. Further, the long term life expectancy of solder interconnects formed with Sn and SnCu finished parts with SnPb solder needs to be demonstrated. Moreover, there is a potential for whisker formation on Pb-free finished terminals.

Approach:
This study will leverage and supplement research initiated under the CALCE Long-term Pb-free Reliability study and focus on the long term reliability of mixed (Pb-free parts/SnPb paste). Mixed test assemblies including Pb-free (Tin Silver Copper solder ball) BGAs, QFPs with Sn, SnBi, SnCu lead finishes will be tested and compared with test pure Pb-free and pure SnPb test assemblies from the CALCE Long-term Pb-free Reliability Study. Tests will be conducted to examine long-term reliability. This program will include

Microstructural analysis of BGA
- As received, 100 hr, 350 hr, and 1000hr aging at 125°C temperature aging.

Lead pull strength test
- Sn, SnBi, SnCu
- Pad finish SnPb-HASL, ImSn, ImAg, ENIG
- Non-Aged, Aging 125°C/100hrs , Aging 125°C/350, Aging 125°C/1000

Interconnect durability tests
- Temperature cycle (-40 to 125°C).
- Random Vibration step stress tests (0.02-0.2 G^2/Hz over test board first frequency)
- Failure analysis of test specimens

Whisker investigation
Sn, SnBi, and SnCu finished parts with SnPb solder will be examined for whisker formation.

All tests and investigations will be documented in reports.

Expected Findings:
- Report on current knowledge relating to mixed (Pb-free parts/SnPb paste) assemblies.
- Interconnect reliability of mixed solder assemblies.
- Comparison of mixed solder assembly reliability with Pb-free and SnPb assemblies.
- Activation energy of intermetallic (Cu_6Sn_5) growth in mixed solder assemblies.
- Documented analysis of microstructure occurring in mixed solder assemblies.
- Pull strength of mixed solder leaded interconnects
- Recommendations for implementing mixed (Pb-free part/SnPb paste) assemblies.

Participation Costs:
$15,000
$25,000 to participate in this study and the Long-term Reliability of Lead-free in Contaminating Environments