Experience in Processing EEE Components with Pure Electroplated Tin Leads As a Ground Base for Lead Free Soldering for Space Electronics Hardware

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Abstract
The regulatory measures defined in MIL performance standards that govern production of active and passive electronic components ban the application of pure Sn plated leads for EEE parts. The standards imply that the top coating of the component leads can contain a maximum of 97% of Tin and a minimum of 3% of Lead as an alloying element. The alloying element reduces the internal stresses present in the pure Tin electroplated coatings and diminishes one of the known causes for whisker growth. However, there are still EEE components on the market that are produced with pure Tin coating on the leads. Some of these components represent an intrinsic part of the successful final product with no viable substitutes. Experience gained in processing the components, in order to make them flight worthy, highly reliable and whisker free, is used in facilitating a transition from Lead solder to Lead free PCA manufacturing. As a result, a positive trend of removing Lead from the first and second level of electronic interconnects is adopted regardless of the currently applicable exemptions for space industry.

This paper presents experimental data collected on pure Tin plated parts and whiskers grown in the period 1991 –2001 on EEE parts; test results confirming material condition producing whiskers growth trends, dimensional analysis and related processing steps used for annulling generation of whiskers are also performed. The successful processing of the related component, and reported experimental data established grounds for challenging the NASA STD 8739.3 statement on limitations of the minimal spacing from the component body for soldering of leads.

Furthermore, the analysis and qualification test results of the particular non SAC solder considered as a potential replacement of Lead containing solders for space application is elaborated for standard electronic assemblies configurations and thermal regimes. A new prospective, affirmed by qualification test data of using this solder for harness interconnects at cryogenic temperature environment also presented.

Keywords- Lead free soldering; Tin Whiskers

I. Introduction

The complexity of using contemporary materials and processes on products designed decades ago is always a challenging task, although essentially needed to maintain the final product performance characteristics, and high reliability requirements.
Material analysis of EEE components, included in several earlier designs, revealed that the following three components may have a termination plating type prone to developing Sn whiskers:

- Semi conductor device per MIL-PRF-19500,
- Resistor per MIL-PRF-55182,
- Switch reed per MIL-S–55433 (cancelled in March 2005)

Except for the switch reed, the Tin content on the other two components was defined in the applicable standards by limiting it to max 97%. Lead content was specified to min 3%.

Based on the difficulty associated with maintaining the insight into individual manufacturer's capability to control and assure exact composition of the plating, combined with the significant freedom of material selection in the above MIL standards, the replacing of the suspected components appeared imminent.

Accordingly, the semiconductor and resistor devices with high Sn content lead coating were replaced immediately with similar components containing less problematic coatings.

However, the replacement of the switch reed component was not feasible due to variety of technical and design related reasons. Therefore the development and implementation of processing technique that will transform high Sn content coating into low Sn content coating on the component lead was undertaken. This processing was designed to be a regular step in PCA component attachment.

In parallel with the process development extensive evaluation of questionable component from old stock was performed. The goal of this investigation was to gain the knowledge of the potential for whiskers growth from high Sn content EEE component leads stored in a controlled storage environment.

Furthermore, the process development applied to overcome this issue has established grounds for potential use of Pb free solders on standard/common components termination coatings designated for Lead type of solders.
This article reports experimental evaluation results on the following actions:

- Identification of whiskers growth rates and relation to component lead coating composition.
- Process development/qualification for complete coverage of component termination during soldering process
- Analysis for Selecting Lead free solders with space heritage
- Process development/ qualification of Lead free solder for cryogenic application.

II. EVALUATION OF HIGH TIN CONTENT PLATING ON THE COMPONENTS FROM THE OLD STOCK

Our experience with Sn whiskers relates to pure Sn plating of a component, and has not been experienced on any other high Sn alloy, such as Sn96. This experience contributes to recognized electroplated Sn material pure state as being the dominant factor in whiskers growth potential

To understand the potential that a particular Tin-plated component may have in growing whiskers the evaluation of the old stock of this component purchased and processed in the period 1991-1998 was performed.

It is important to note that the processing of the component included the leads tinning by a hot Sn 63 solder pot dip in accordance with the NASA guidelines in place at the time as specified in NHB 5300.4 (3A-2).Soldered Electrical Connections. This solder tinning process covers most of the component lead coverage, and Tin integration into the solder, except for a narrow land in the close proximity to the component body. The presence of those small regions of very high Sn content residual coating from electro plating was thoroughly investigated from the prospective of favorable conditions for growth of Tin whiskers.

In conclusion, this evaluation identified presence of very small whiskers. The biggest whisker was a fraction of a thousandth of an inch long. See Figure1.

Figure 1 - The Whisker

The density and length of whiskers were not related to the age of the component, as 1991 manufactured components showed similar whisker growth to the one dated 1998. The majority of whiskers exist in very short nodular form 2.54 μ (0.0001") high and 2.54 μ (0.0001") diameter. The biggest whisker found was 16 μ (0.00063") long and 3μ (0.00012") diameter. Data analyses showed that the whiskers grow to a certain maximum length typically in a range of 1μ (0.0004")-1.5μ (0.0006").
The following two SEM images show the population of whiskers and the typical size and form of a "nodular" whisker structure. See Figure2

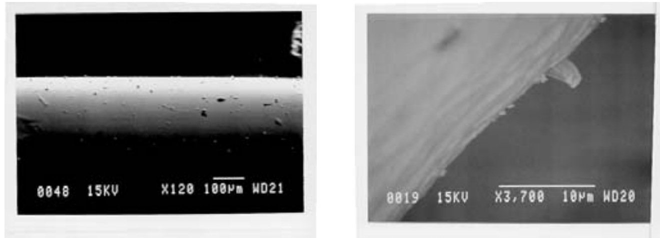


Figure 2 - The Whisker Population

Growth Rate Estimates

Calculation of whisker growth rate was performed from empirical data on whiskers size acquired on 10,9,8,7,6 and 3-year-old batches of the components. Growth rate of whiskers was estimated from the maximum length of the whiskers on inspected samples. Fig 3 shows examples of obtained data.

Item No.	Year of Manufacture	Length of Residual Sn [micron]	Maximal Length of Whisker [micron]
1	1991	2380.8	6.04
2	1992	998.4	10.09
3	1993	5043.2	10.09
4	1993	3635.2	0.00
5	1993	4224.0	0.00
6	1993	4224.0	11.08
7	1994	3430.4	8.06
8	1994	3840.0	10.09
9	1995	3635.2	9.06
10	1995	4019.2	8.06
11	1995	3840.0	0.00
12	1995	4121.6	6.04
13	1995	998.4	0.00
14	1995	998.4	10.09
15	1995	4121.6	8.06
16	1998	3020.8	12.08
17	1998	2278.4	10.09

Figure 3 - Whiskers Dimensional Analysis Data

The following Figure 4 indicates estimated rate of whiskers growth.

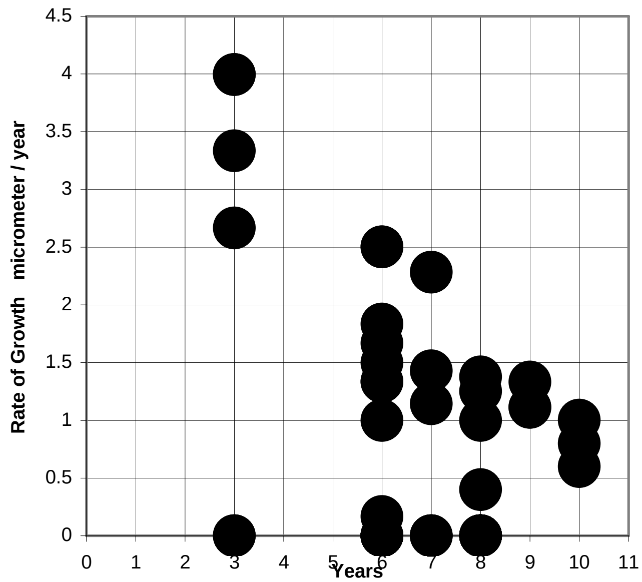


Figure 4 Growth Rate of Whiskers

III. COMPONENT PROCESSING EVALUATION

This evaluation was a first step in estimating the component capability to withstand the soldering temperature environment when leads were reflowed all the way to the component glass body.

Evaluation Flow and Samples

The sample of 5 PCA's (Printed Circuit Boards) each with 3 investigated components (S1, S2, S3) attached with Sn 63 solder and evaluated by the SEM/EDX technique.

Components identified as S1 and S3 were additionally reflowed by applying specially developed rework technique, which, included reheating the component leads, and adding a small amount of Sn 63 solder to flow/ wet the whole lead up to the component glass body. Each lead was reworked the same way.

The third component, S2 was not additionally reflowed; it was designated as a control sample.

The coating composition of reworked and control samples leads were scanned, without removal from the PCA at three locations along the lead. The first scan was taken at the end point of the solder joint, the second at the formed portion of the lead, and the last one in the close proximity to the component body.

Evaluation Results

The total number of EDX scans was 9 per component comprising 90 scans on reworked components, and 45 scans on 5 control samples. During the course of evaluation it was identified that only the area of the lead in the very close proximity to the component body is critical regarding the Tin content.

The representative results of the EDX evaluation, of the lead coating of components assembled on four from five PCA's is shown in the Fig 5, Tin Content of Component Lead Coating.

PCA No.	Processed Component Lead Coating Content Sn [%]	Control Sample Lead Coating Content :Sn[%]
1	Sn81 L*~. 100 μ	97 L*~. 100 μ
2	Sn 83 L*~. 100 μ	90 L*~. 100 μ
3	Sn 72 L*~ 80 μ	96 L*~. 100 μ
4	Sn 79 L*~ 25 μ	97.9 L*~. 100 μ

Figure 5 - Tin Content of Component Lead Coating

L* Distance from the component glass body.

Following the SEM/EDX analysis, the PCA's were submitted to a workmanship screening. No deficiencies of component and solder joint material integrity were identified.

The following Fig 6 shows the typical view of the component lead condition after soldering.

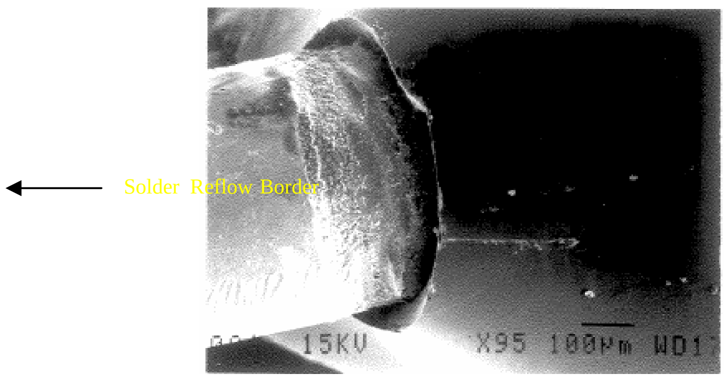


Figure 6 - Component Lead Post Soldering

It was concluded that Sn 63 solder reflow was successful in altering high Sn content of the lead coating from in the worst case 97.9 % (PCA No4, Control Sample) to 83% (PCA No.2 Processed Sample). The distance from the component body to the observation points where those results were achieved was in the range 25[μ] to 100 [μ].

Applicability of NASA STD 8739.3 Requirement for Preparation for Soldering

To solve the issue of high Tin content plating of the component lead, the pre tinning process with low Tin content solder, per the related NASA standard, Chapter 7 Preparation for Soldering, was considered for application.

The paragraph 7.2 states that the depth of immersion of the component lead into the hot solder shall not be closer than 0.5[mm] (0.020in) from the component body.

This requirement is understood as a protective measure for the component, from being exposed to the excessive heat from the molten solder. It is also understood that this dimension relates to the thermal environment development in the component body during tinning in the solder pot at a maximal survival temperature during solder dip application in duration of 5±0.5[sec], at 245 ±5°C, as specified in the MIL-STD 750, Method 2026, Solderability, Paragraph 4.3.2 Solder Dip Terminations Procedure. This particular requirement, unless exempted from in the component technical data sheet, is a common requirement for majority of EEE components.

In order to assure that during pre tinning process a depth of immersion is producing complete integration of Tin onto the Sn 63 alloy, and the solder flows to completely cover the lead plating, the above mentioned NASA requirement, of 0.5[mm] could not be adopted. To overcome this obstacle a process adjustment was made by applying a provision, from the same standard requiring qualification of the soldering process, in our case pre tinning process, to confirm the process and component unchanged reliability. The process adjustment contained the following elements: increased depth of the immersion in the hot solder pot, development and application of the measures/tools for component thermal protection.

The final and the most significant aspect of the qualification was a confirmation of existing screening technique for the component material integrity and performance evaluation.

In conclusion, the results of process qualification confirmed the efficiency of processing in assuring complete integration, i.e. coverage of the component lead original coating into the selected type of solder, without affecting component material integrity and performance.

The acquired complete coverage of the component terminations and the related Sn content on the lead coverage is better than representative results presented in Fig 5.

IV. AFFECT OF PROCESSING OF HIGH TIN COMPONENT LEAD ON LEAD-FREE SOLDERING

Standard J STD 006 is recognized and accepted by electronic industry as a regulatory document governing quality of solders and solder fluxes from the prospective of defining solder physical characteristics and related standardized testing techniques. It also contains, in Appendix A, an extensive list of solders applicable in electronic industry with clearly defined composition of the alloying elements including impurity types, limits and weight content.

Among all those standardized solders, a eutectic solder alloy Sn96Ag 04 in the “E” designated impurity level is considered as Pb free solder. The variation “E” specifies the maximal amount of Lead to 0.1%, and Antimony (Sib) content to 0.2%.

The definition of Lead free solder, as specified in European directive RoHS 2002/19/EC (Restriction of Hazardous Substances) is max 0.1% of Pb. Eutectic solder alloy Sn96Ag 04 E fully qualifies as Lead free solder.

The above mentioned RoHS document was effective in the European Union on July 1, 2006. [1], and in addition to Lead it also regulated limits of various other toxic materials.

Space hardware is not referred to in related RoHS directive.

Consequently, ESA (European Space Agency) maintains the standpoint that the well known solders containing Pb, such as Sn63, and In50 shall not be considered for replacement.[2]

In general terms, the intention of removing Pb from the electronic industry products is continuation of a broader process in raising environmental awareness. For many centuries Lead toxicity was recognized even though , all aspects of its medical affect on humans have not been discovered yet .We consider that the removal of Lead from the solders, hence reduction of Lead from the environment, presents additional small contribution, at relatively low economic impact, to a cleaner and more livable earth.

Where ever the reliability of the product is not negatively affected, the replacement of high Lead content solders /products shall be realized.

Status of control of Pb in Canada is related to concentration of Pb in soil of max 140[mg/kg] [3].

Lead-free Solder Alloys Cost Analysis

In order to evaluate the basic financial impact of the raw material for replacing Pb containing solders with Lead-free solder, the costs associated with purchased and used quantities of Sn63, Sn 62, and Sn96 solders in years 2003, and 2004 were compared with average price paid for the same period for Sn96 solder. This analysis revealed that in case of complete replacement of solders Sn63, and Sn 62 in wire form with Sn 96, the cost impact for average quantities for 2 years, and reasonably similar prices for individual solder types, will be approximately 25% higher. The price increase of the raw material, and its affect on the total cost for the manufacturing of the product was considered in the light of the amount of actually used solder, and the cost associated with processing adjustments /developments.

Solders Used for Space Hardware

Without a doubt, Sn 63 has been the most applied type of solder for building space hardware; it has been a dominant type of solder used across all soldering configurations and product lines.

Different types of Pb free solders were also used extensively on virtually all space programs to date, in order to accommodate specific technical requirements associated with either facilitating assembling process flow, or providing the high reliability solder joints when interconnecting components/hardware with specific types of metallization. Hitherto, the application of Sn 96 solders was intensively used for two-step soldering and interconnecting the Ag plated substrates. Therefore a significant experience has been acquired in all aspects of processing of the related alloy.

The fact that the space qualified and standardized processing already exists for Pb free solder such as Sn96E, the individual Sn 63 replacement would require only qualification related to thermal and mechanical stress environment of particular hardware geometry and final product requirement.

V. CRYOGENIC APPLICATION OF LEAD FREE SOLDERS.

For EEE components that are required to operate in cryogenic environment at-258°C (15°K), the evaluation of component interconnect was performed.

A critical element in planning this evaluation process was the proper design of the test vehicle.

By definition, the test vehicle for qualification shall contain exact hardware configuration per the final (flight) design. Geometrical features, as well as applied materials and processes shall be identical to the final design. Mechanical and thermal stress environments for test vehicle exposure shall be representative of specification requirements for the final product.

Following those principles, the electrical interconnect of EEE components were evaluated on three test vehicles, one of which is revealed in the Figure7 Harness Cryogenic Test Set-Up

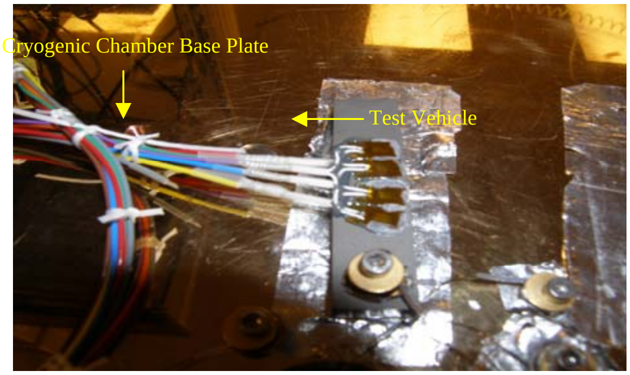


Figure 7 - Harness Cryogenic Test Set-Up

The description of this test vehicle is four components (type of Flex CCT) bonded over the Tiodized Ti alloy substrate with an epoxy based adhesive; CCT's are interconnected /soldered to wire harness with Lead free solder. The material for investigation relevant to this report is a lead free solder Sn96.

Qualification Process

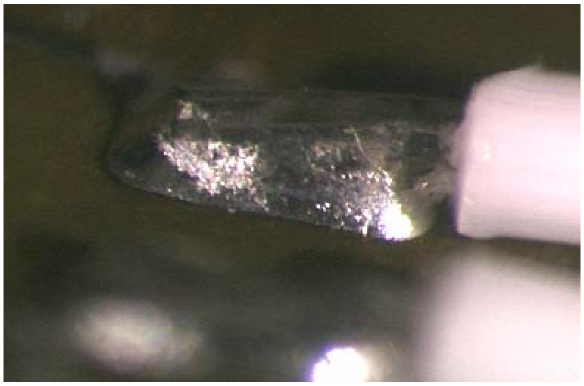
The qualification process flow was focused on investigating among other materials and processing features, the capability of solder joints to withstand the stress caused by mismatch of CTE (Coefficient of Thermal Expansion) of all integral parts involved in the test vehicle structure. As mentioned above, not only materials and processes, but also dimensions /geometry of the integrated features are either exact, or have high similarity to the flight design. A decision on the level of similarity of this test vehicle to the flight design was based on the anticipated criticality of the individual components features. For example, the adhesive bond line thickness, dimensions, and mass of the substrate for bonding and solder joints geometry were identical. to the final product design.

The qualification process flow started with building the test vehicles per flight standards processing techniques, with integrated inspections quality control steps. The test vehicles were then exposed to thermal stress in cryogenic environment by cycling between +23°C and -258°C

Following the thermal stress test vehicles were evaluated on material integrity using visual and SEM and DPA (destructive physical analysis) techniques.

Solder Joints Material Integrity.

Initial evaluation of solder joints integrity was performed visually by optical microscope. The following Fig 8 shows Typical Solder Joint after Cryogenic Exposure.



Gig 8 - Typical Solder Joint After Cryogenic Exposure

Comparison of solder joints surface appearance prior and after exposure to cryogenic environment did not reveal any signs of deterioration or cracks. The SEM image presented in Figure9, reveals the surface morphology of a typical post cryogenic exposure solder joint.

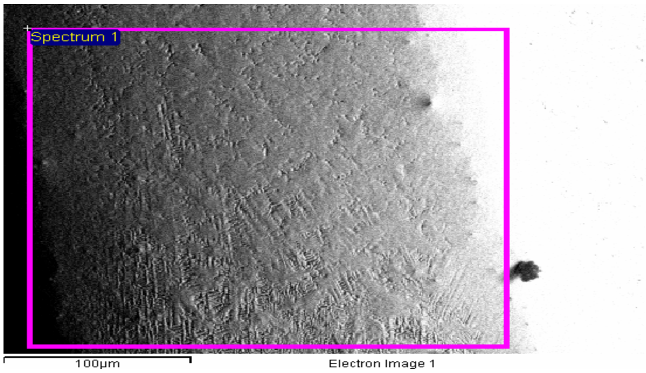


Figure 9 - Typical Surface Morphology of Solder Joint Post Exposure to Cryogenic Temperature

Cross sections of the solder joints affirmed the good material integrity of the solder. The interfaces between the solder and the substrate (component pad) as well as the wire conductors were intact. Fig 10, Cross Section of the Led Free Solder Joint after Exposure to Cryogenic Temperature, provides an image of solder structure. No cracks or separations at the interface with the joining materials were identified.

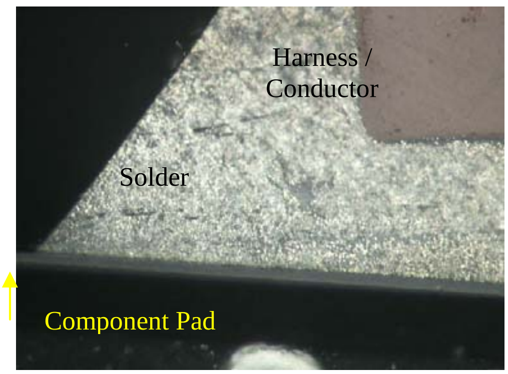


Figure 10 - Cross Section of the Led Free Solder Joint After Exposure to Cryogenic Temperature

In conclusion, the processing and materials applied for building test vehicles, including solder are considered acceptable for application to further development/qualification step.

CONCLUSION

Processing of EEE components to eliminate high Tin content electro plated coating on leads have been accomplished with no negative affect on the component reliability, material integrity and performance. The presence of whiskers on Tin electroplated plated component leads was confirmed and evaluated by SEM/EDX analysis. The growth rate of whiskers was derived based on measured sizes of the actual specimens.

A method of successful processing for complete coverage of the component original coating was developed. As a result, this method can be extended for use on regular components for non-SAC lead free soldering.

Initial results on Sn96 behavior in cryogenic environment are a solid ground for further development.

ACKNOWLEDGMENT

The support of COM DEV management in making available data from a number of internal reports to be published is greatly appreciated.

REFERENCES

[1] Handbook for Lead Free Solder Technology for Microelectronic Assemblies, Marcel Dekker Inc, New York, 2004.

[2] ESA CTB (European Space Agency Component Technology Board) Lead-Free Task Force Meeting Summary, Doc QM/06-362/BD/MH http://esmat.esa.int

[3] CCME Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines http://www.gov.nf.ca-env

[4] Electroplated Tin and Tin Whiskers in Lead Free Electronics Fred.W Verdi 11/5/04 American Competitiveness Institute, Philadelphia, PA

Experience in Processing EEE Components with Pure Electroplated Tin Leads As a Ground Base for Lead Free Soldering for Space Electronics Hardware

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Lead Free for Space- WHY?

Pb content ~ 0%

RAISED ENVIRONMENTAL AWARENESS.

Pb content = X%

MEDICAL AFFECT ON HUMANS

Pb content ↘

MORE LIVABLE EARTH

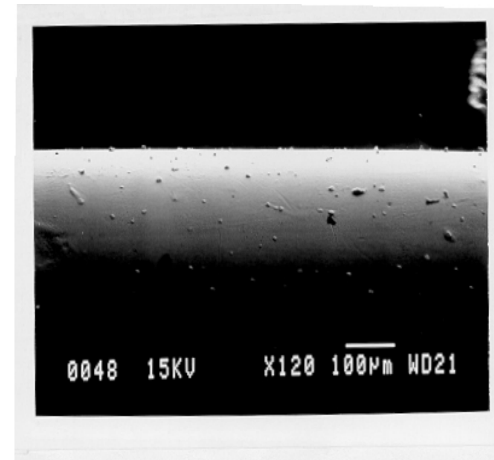
The removal of Lead from solders hence reduction of Lead from the environment is a small contribution at relatively low economic impact

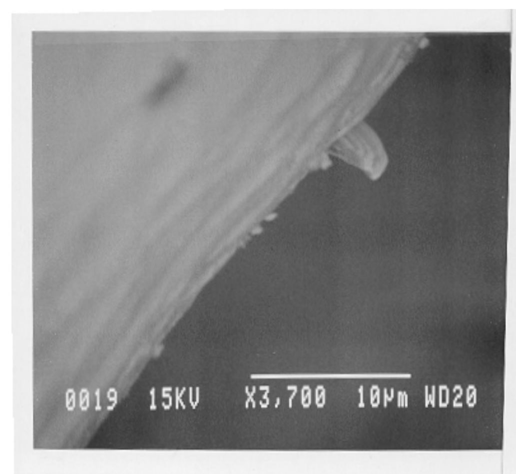
RoHS 2002/19/EC (Restriction of Hazardous Substances) does not refer to Space Industry

INRODUCTION

Dealing with the past

- Successful performance of an mature product
- Everlasting Requirements for High Reliability
- Contemporary Materials and Process





INRODUCTION

Dealing with the past.

- EXTENSIVE EVALUATION OF THE COMPONENT FROM THE OLD STOCK

- STORAGE CONDITION: 22.5 ± 2.5 °C, 30-55% RH

- COMPONENT CONDITION

1. Component Build Standard MIL-S-55433
2. Manufactured and Acquired 1991-1998
3. Lot Size 17
4. Rough lead surface found on ~76% of leads

INTRODUCTION

Dealing with the past.

- SEM/EDX

Rough Surface ⇔ Whiskers

- SHAPE

Nodular (majority)

Needle

- SIZE

Range: 2.54 µ by 2.54 µ

Max:16 µ by 3 µ

Item No.	Year of Manufacture	Length of Residual Sn [micron]	Maximal Length of Whisker [micron]
1	1991	2380.8	6.04
2	1992	998.4	10.09
3	1993	5043.2	10.09
4	1993	3635.2	0.00
5	1993	4224.0	0.00
6	1993	4224.0	11.08
7	1994	3430.4	8.06
8	1994	3840.0	10.09
9	1995	3635.2	9.06
10	1995	4019.2	8.06
11	1995	3840.0	0.00
12	1995	4121.6	6.04
13	1995	998.4	0.00
14	1995	998.4	10.09
15	1995	4121.6	8.06
16	1998	3020.8	12.08
17	1998	2278.4	10.09

INRODUCTION

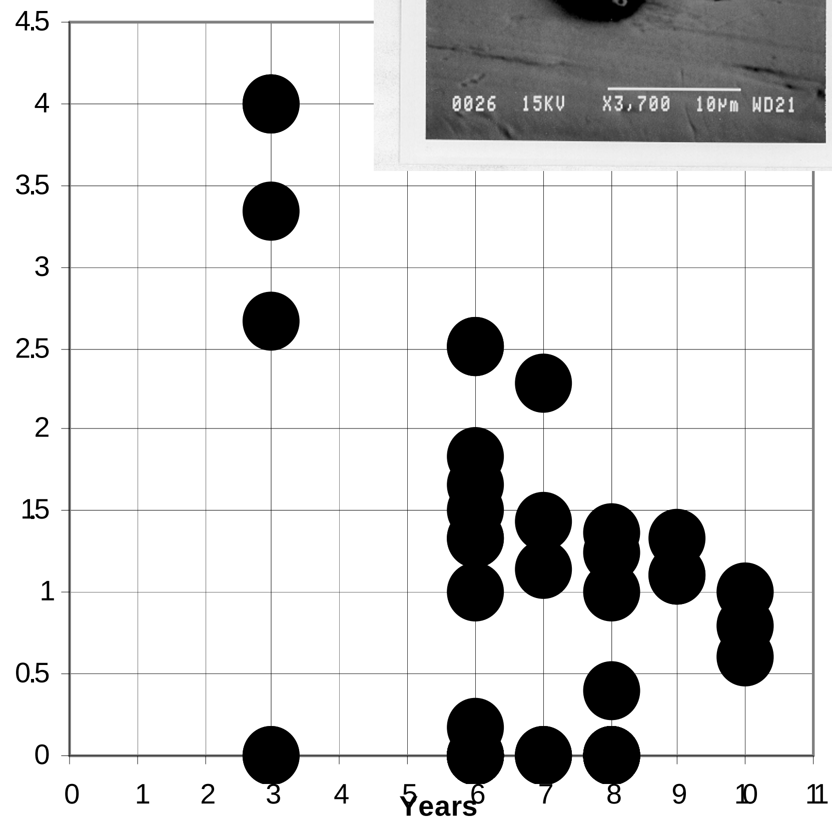
Dealing with the past.

CONCLUSIONS DERIVED FORM WHISKERS GROWTH RATE INVESTIGATION

Maximal length not affected by:

1. The component plating age
2. The amount of available pure Sn
3. Root cause for generation remain specific

   to individual component material condition



COMPONENT PROCESS DEVELOPMENT REQUIRED TO

PROVIDE COMPLETE COVERAGE OF ORIGINAL PLATING

PROCESS DEVELOPMENT- ITRODUCTORY STAGE

Building on experience with Sn whiskers

1. Selection/assembling of EEE with Sn plating into PCB's

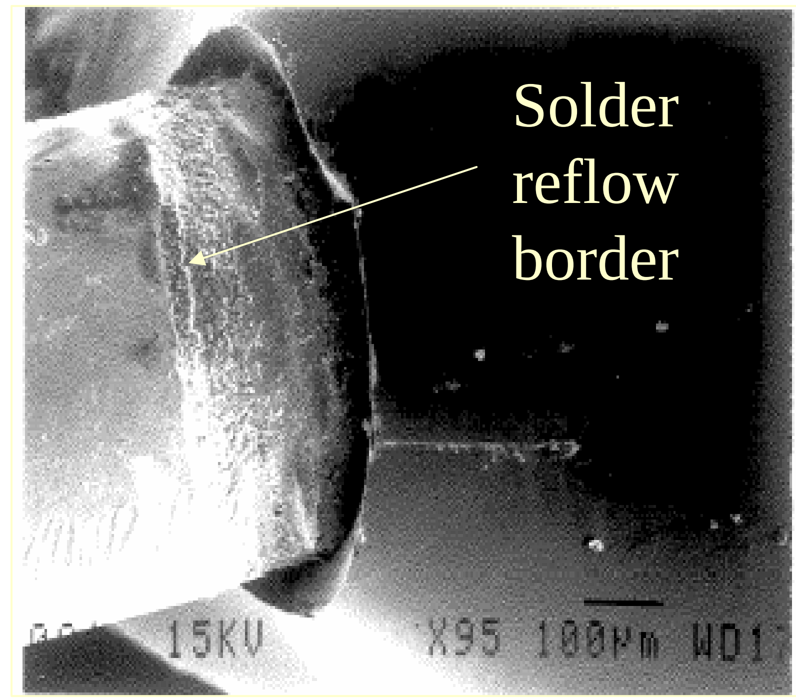
2. Attachment with Sn 63 & NASA STD 8739.3

3. SEM/EDX analysis of un covered plating

PROCESS DEVELOPMENT- ITRODUCTORY STAGE

Building on experience with Sn whiskers

4. Defining Max. Temperature EEE can withstand
5. Performing additional soldering / rework on EEE leads
3. SEM/EDX analysis of covered plating



PROCESS DEVELOPMENT- ITRODUCTORY STAGE

Building on experience with Sn whiskers

4. Developing testing technique for validation EEE material integrity
5. Performance evaluation of processed EEE

PCA No.	Processed Component Lead Coating Content Sn [%]	Control Sample Lead Coating Content Sn [%]
1	Sn81 L ~100 μ	97 L ~.100 μ
2	Sn 83 L ~100 μ	90 L ~.100 μ
3	Sn 72 L ~80 μ	96 L ~.100 μ
4	Sn 79 L ~25 μ	97.9 L ~.100 μ

Sample size:15 Components on 5 PCA's 9 EDX per Component

PROCESS DEVELOPMENT- ITRODUCTORY STAGE

Conclusions

- The Sn 63 solder reflow was successful in altering high Sn content of the lead coating.
- Worst case example:

  Sn reduced from 97.9 % to 83% measured at a distance from the component body of 25[μ] to 100 [μ].

PROCESS DEVELOPMENT- ITRODUCTORY STAGE

Conclusions

- Component material integrity including solder joints not affected
- Component performance and reliability unchanged

PROCESS QUALIFICATION-ESTABLISHING GROUNDS

Applicability of Depth of Immersion in Solder Pot

- Distance of component body shall be minimum 0.5 [mm] or 500 [μ]

  (NASA STD 8739.3 Paragraph 7.2)

- Complete coverage requires ≤ 100 [μ]

PROCESS QUALIFICATION- DECISION POINT

Applicability of Depth of Immersion in Solder Pot

COMPLETE INTEGRATION OF ORIGINAL EEE TERMINATION PLATING INTO SOLDER ATTACHMENT MEDIA REQUIRES DEPTH OF IMMERSION $\leq$ 100 [μ] FROM THE COMPONENT BODY

Qualification is required

PROCESS QUALIFICATION
Concept and achievements flown from Introductory Stage of process development

- Development and application of measures/tools for component thermal protection.
- Increased depth of the immersion in the hot solder pot
- Confirmation of existing screening technique for the component material integrity and performance evaluation

LEAD FREE SOLDERS
Availability of Non (Sn Ag Cu) types.

- J STD 006
- Sn96Ag04, E   (0.1% Pb, 0.2% Sb)
- Qualifies as Pb free solder per RoHS 2002/19/EC

LEAD FREE SOLDERS

Advantages of using Non (Sn Ag Cu) types

1. Processing for Sn96 is well known/qualified and extensively used.

2. Processing for complete lead coverage is qualified for certain types of EEE's

3. Cost increase for raw material replacement of Sn 63 is reasonably low ~ 25%

LEAD FREE SOLDERS

Additional work required for use of Non (Sn Ag Cu) types

REPLACEMENT OF SOLDERS CONTAINING Pb WOULD REQUIRE ONLY QUALIFICATION TO ADRESS FINAL PRODUCT RELIABILITY BASED ON :

- THERMAL STRESS ENVIRONMENT
- MECHANICAL STRESS ENVIRONMENT
- PERFORMANCE REQUIREMENT.

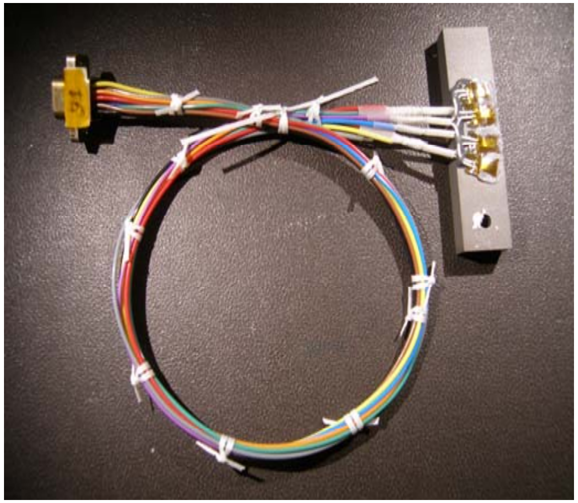
LEAD FREE SOLDERS - QUALIFICATION
Cryogenic Application of Non (Sn Ag Cu) types

For EEE components that require to operate in cryogenic environment of -258°C (15°K), the evaluation of component interconnects with Sn96 was performed on the Qualification Test Vehicles

LEAD FREE SOLDERS - QUALIFICATION
Cryogenic Application of Non (Sn Ag Cu) types

Test Vehicle Definition

- Exact hardware configuration per the final (flight) design.
- Geometrical features, as well as applied materials and processes shall be identical to the final design

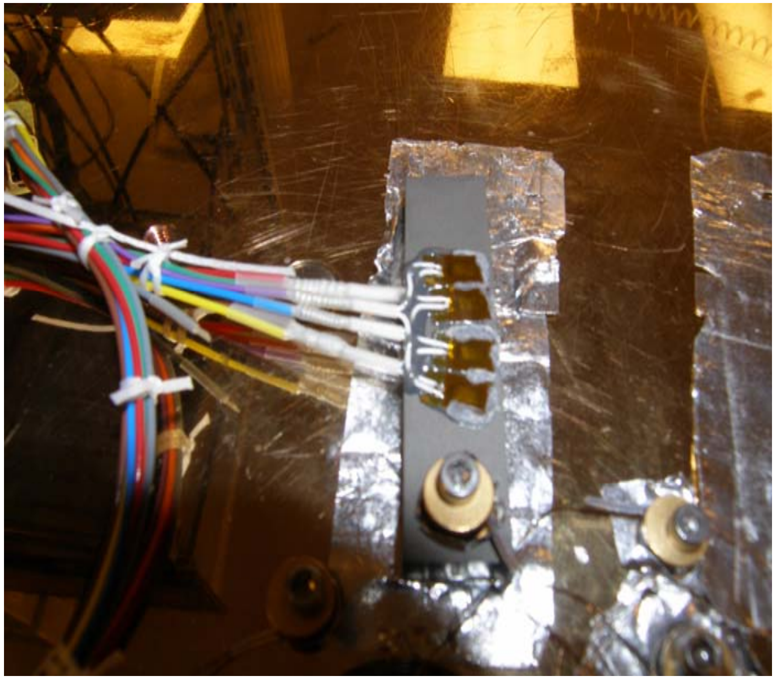


LEAD FREE SOLDERS-QUALIFICATION
Cryogenic Application of Non (Sn Ag Cu) types

STRESS REQUIREMENTS

- Mechanical
- Thermal

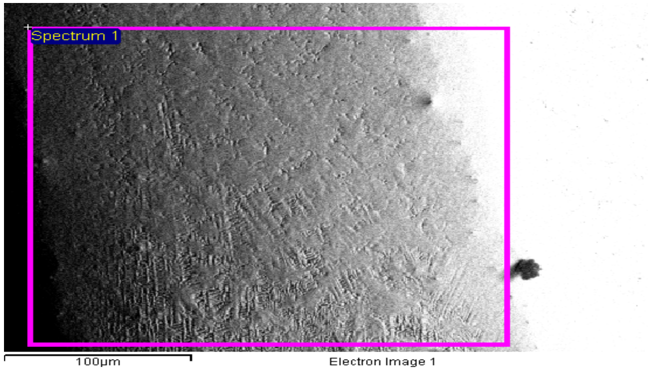
Representative/identical to specification requirements for the final product.

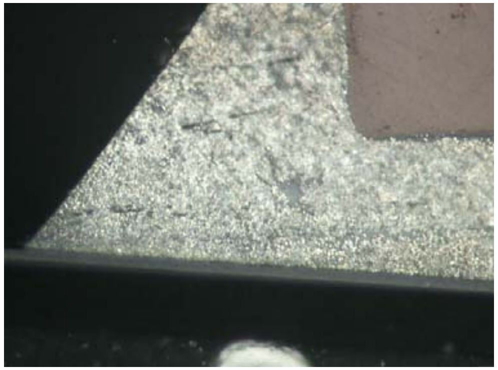


LEAD FREE SOLDERS-QUALIFICATION

Cryogenic Application of Non (Sn Ag Cu) types

RESULTS





LEAD FREE SOLDERS-QUALIFICATION
Cryogenic Application of Non (Sn Ag Cu) types

RESULTS

Solder Joints:

Material integrity not affected by exposure to cryogenic environment.

Test Vehicle :

No signs of any deterioration of integral parts including component adhesive bond to substrate.

LEAD FREE SOLDERS-QUALIFICATION
Cryogenic Application of Non (Sn Ag Cu) types

CONCLUSION

Processing and materials applied for building test vehicles, including solder are considered acceptable for application to further development/qualification

LEAD FREE SOLDERS-CONCLUSION

1. Coating of electro plated leads have been accomplished
2. The presence of whiskers was confirmed and evaluated; growth rate derived from the actual specimens.
3. A successful processing for complete coverage of the component original coating was developed and can be extended for use on regular components for non-sac lead free soldering.
4. Initial results on Sn 96 behavior in cryogenic environment are a solid ground for further development.