



Legs 1, 2 & 3: Olin 194 8lead SOIC Molded/Singulated

Leg #	Test sequence	Sample	Whisker (yes/no)?	Max. length	Comments
1	500 -55C/85C TC	A	no		
		B	no		
		D	yes?	1µm	May be too short
2	4weeks 60C/95%RH Storage	A	no		
		B	no		
		D	no		Odd feature on D1
3	500 -55C/85C TC plus 4weeks 60C/95%RH Storage	A	yes?		Whisker clusters?
		B	no		Corrosion
		D	yes?	1µm	May be too short

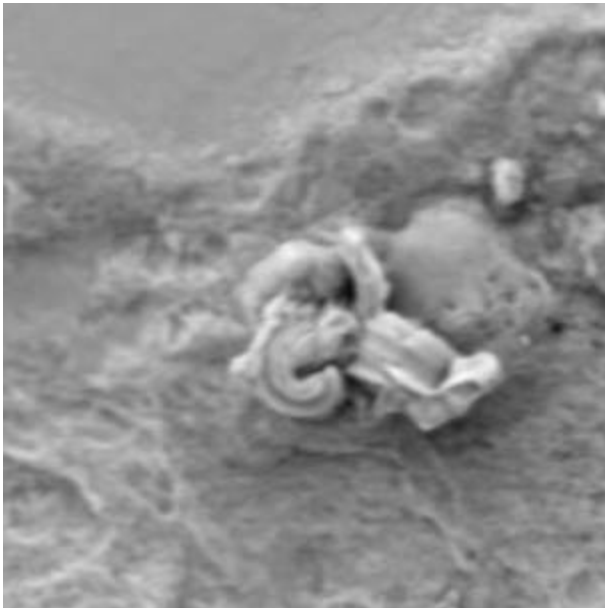
From Phase1 DOE

A = 50-100 pinches Bright Sn B=500-600 pinches Bright Sn D=500-600 pinches Sn/10Pb

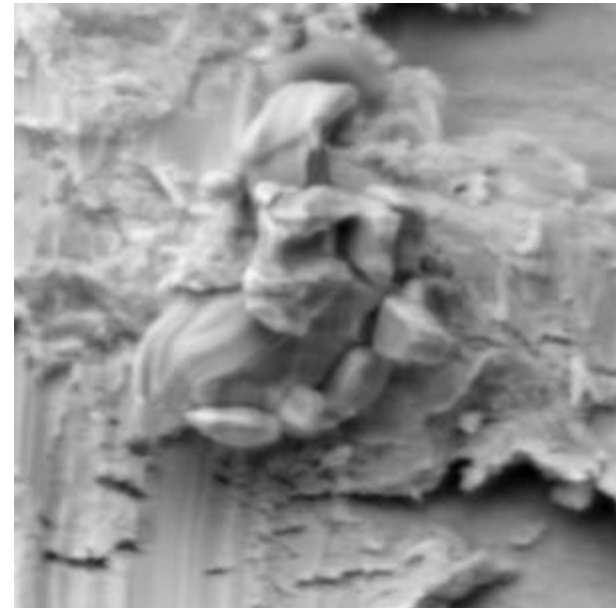
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Sample Set A: 50-100 μ inch Bright Sn, Olin 194 8 lead SOIC Molded/Singulated



Leg# 3, unit A2, **lead 1**: 500 –55C/85C
TC plus 4weeks 60C/95%RH Storage.
Possibly whisker clusters.



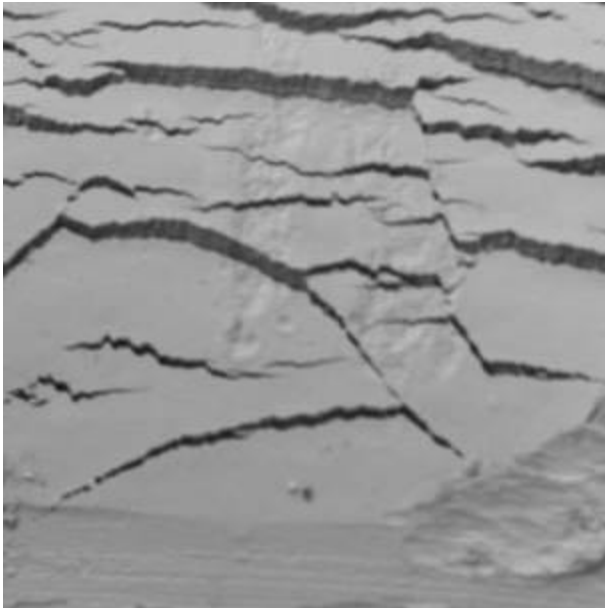
Leg# 3, unit A2, **lead 2**: 500 –55C/85C
TC plus 4weeks 60C/95%RH Storage.
Possibly whisker clusters.

- Set A did not show signs of whisker growth after 500 –55C/85C temp cycles or 4weeks 60C/95%RH storage.
- However, clusters, which could be whiskers, were present when Set A samples were subjected to 500 –55C/85C temp cycles followed by 4weeks 60C/95%RH storage.

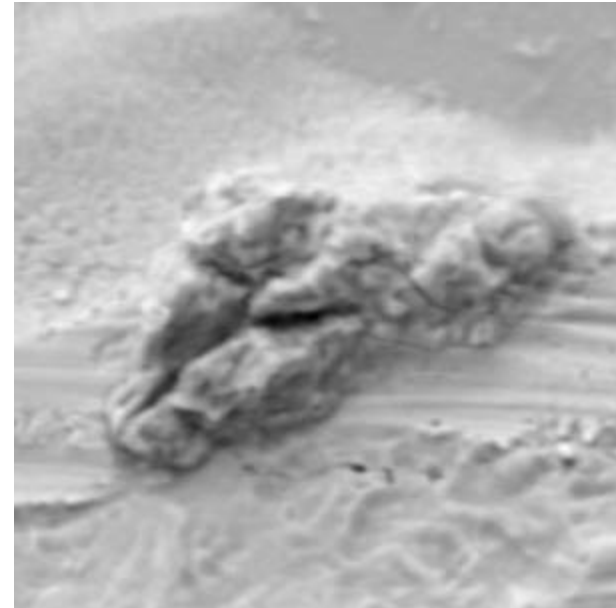
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Sample Set B: 500-600 μ inch Bright Sn, Olin 194 8 lead SOIC Molded/Singulated



Plating cracks observed at time zero.



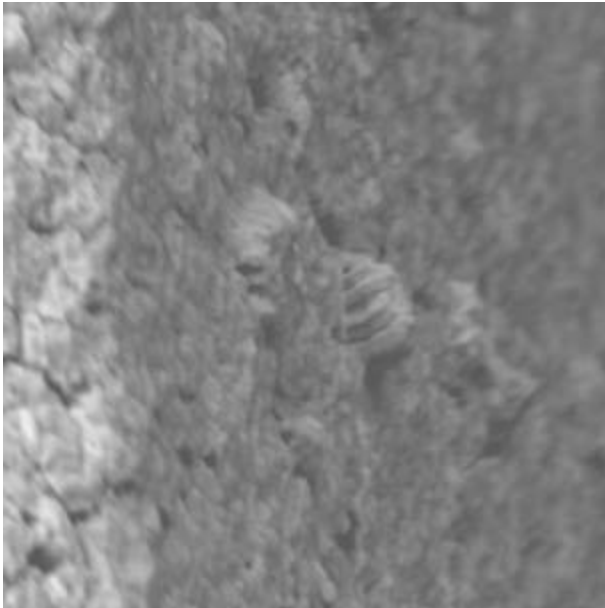
*Leg# 3: 500 –55C/85C TC plus
4weeks 60C/95%RH Storage.
Beginning to corrode.*

- Whiskers were NOT observed in any of the legs.
- Cracking may have reduced or eliminated internal stress.

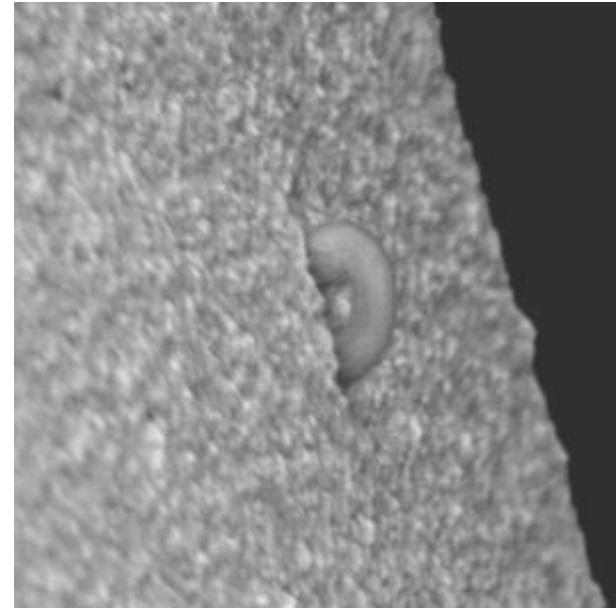
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Sample Set D: 500-600 μ inch Sn/10Pb, Olin 194 8 lead SOIC Molded/Singulated



*Leg# 1: 500 –55C/85C TC.
Onset of a possible whisker.*



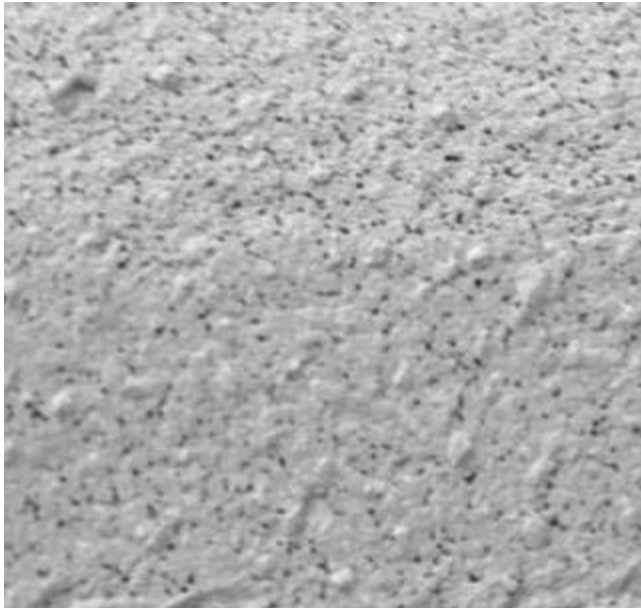
*Leg# 2: 4weeks 60C/95%RH Storage.
Not likely to be a whisker.*

- Set D samples appear to form short whiskers after 500 –55C/85C temp cycles.
- Odd shaped features were observed after 4weeks 60C/95%RH storage, however, although the features appear whisker-like, the lack of striations make it unlikely to be whiskers.

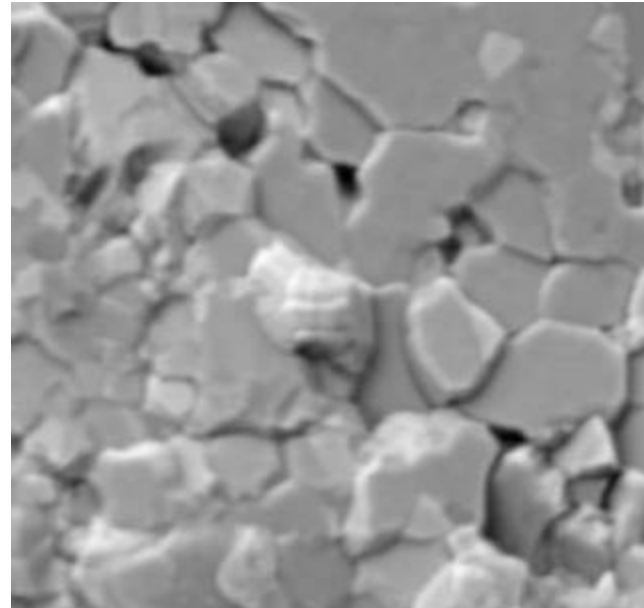
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Sample Set D: 500-600 μ inch Sn/10Pb, Olin 194 8 lead SOIC Molded/Singulated



*Leg# 3: 500 –55C/85C TC plus
4weeks 60C/95%RH Storage.
Low magnification.*



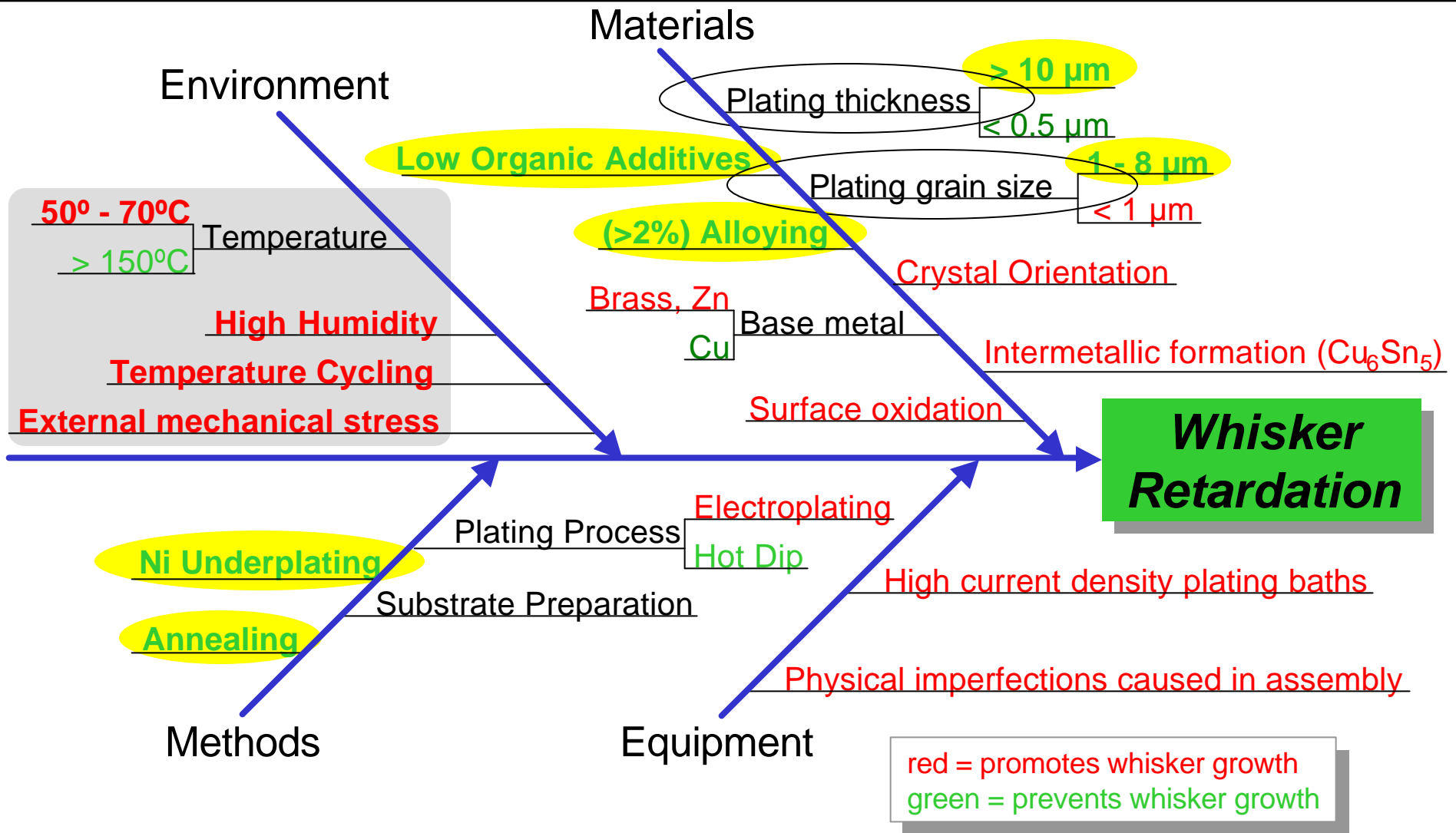
*Leg# 3: 500 –55C/85C TC plus
4weeks 60C/95%RH Storage.
High magnification.*

- **Set D samples appear to form short whiskers after 500 –55C/85C temp cycles plus 4weeks 60C/95%RH storage.**

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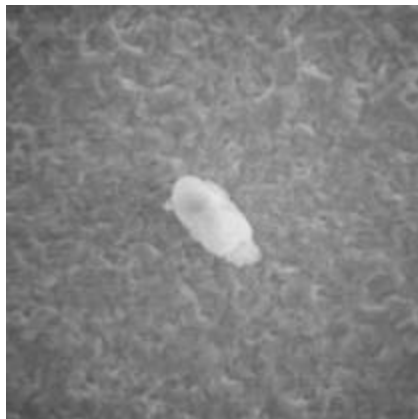
Whisker Growth Literature Research



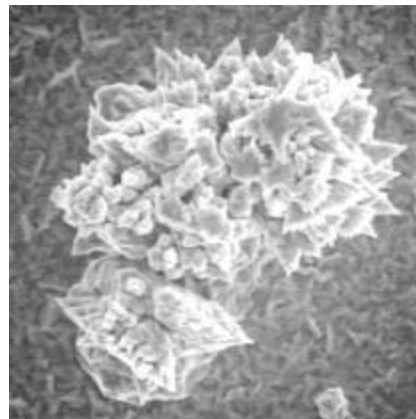
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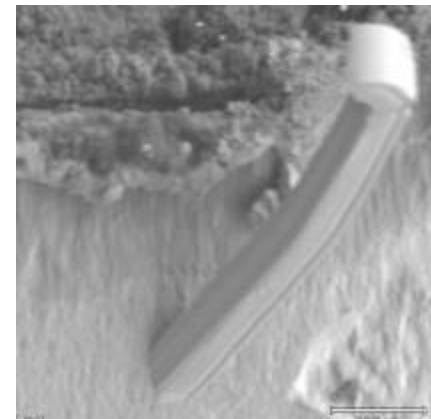
Whisker Types



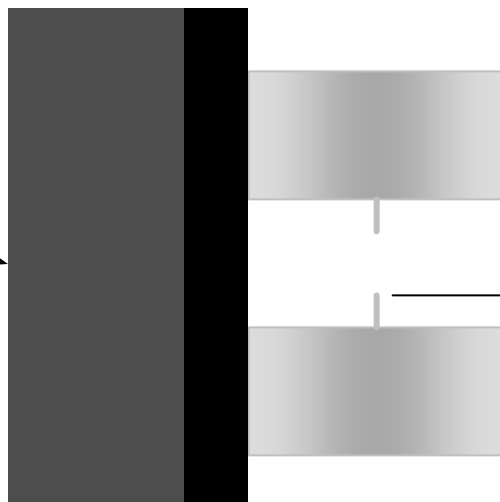
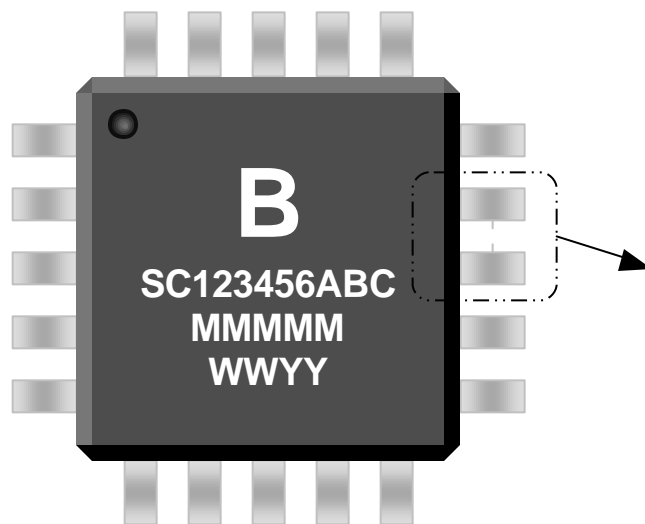
Lump Whisker



Flower Whisker



Needle Whisker



Needle whiskers can potentially cause a short

Criteria: [75µm]

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64 LQFP Whisker Acceleration Study

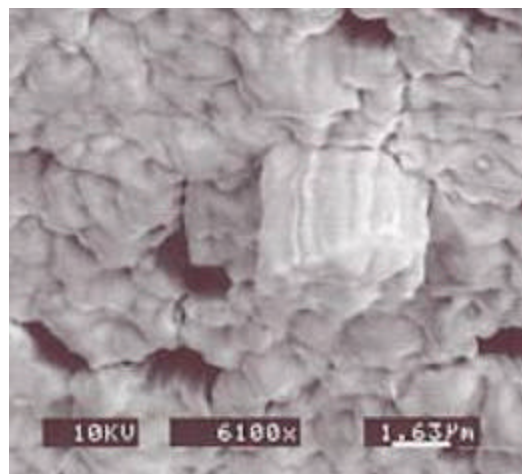
Whiskers formed with either 60°C/95%RH storage or -55°C/85°C temperature cycling.

Plating Finish	60°C/95%RH 3 weeks	85°C/85%RH 500 hours	121°C/100%RH 576 hours	-55°C/85°C 500 cycles	-35°C/125°C 500 cycles
Sn/2Bi	No whiskers	No whiskers	No whiskers	Whiskered	No whiskers
Sn/10Pb	Whiskered	No whiskers	No whiskers	Whiskered	No whiskers

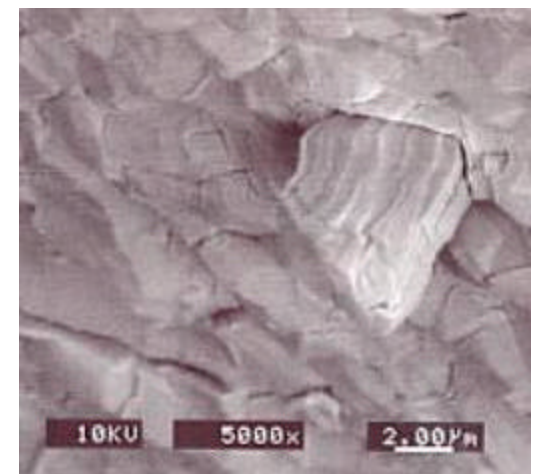
Sn-Pb Needle Whisker



Sn-Bi Needle Whisker



Sn-Pb Needle Whisker



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Whisker Growth Test Flow

Sample size 3 units. Die & wirebond required.

Initial Inspection

Handle units with vacuum wand or tweezers.

- 1) Attach the package (live bug) to the SEM work holder using double-sided carbon tape.
- 2) Use air or N2 to blow off debris (optional).
- 3) At 300X magnification, inspect 3 random leads per package for whiskers.

Temperature Cycle (air-air)

-55±5°C/85±5°C, 500cyc; 7minute hold;
5minute ramp; 24minutes/cycle

AND

Temperature & Humidity Storage

60°C/95%RH, 500hrs

Post Inspection

Attach the package to the SEM work holder according to “Initial Inspection” steps 1 and 2.

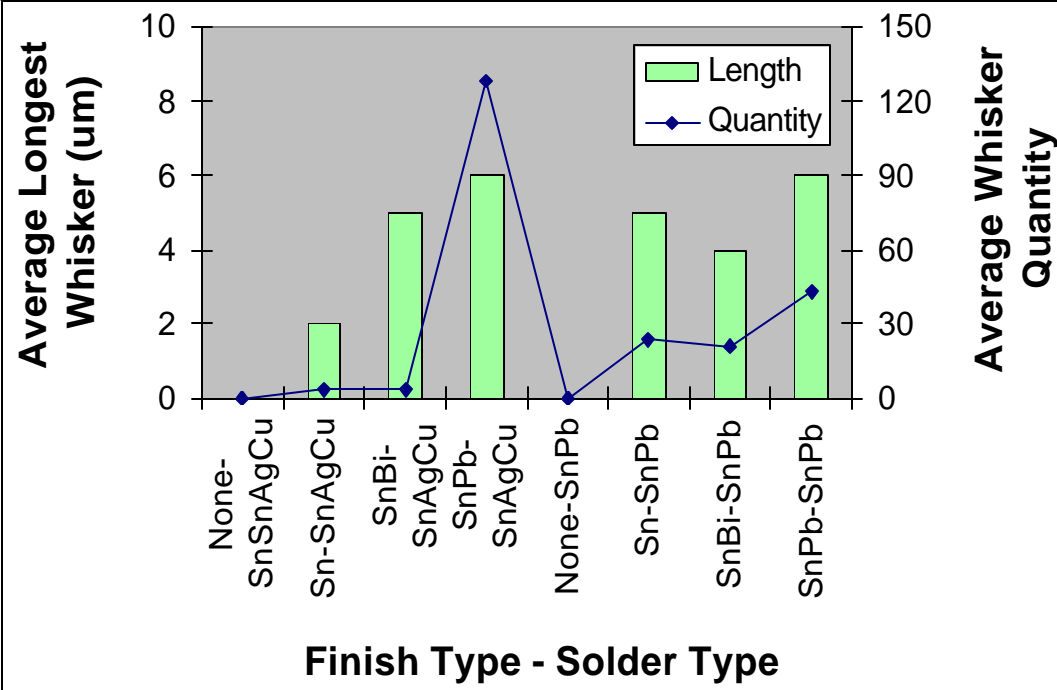
- 1) At 300X magnification, inspect 3 random leads per package for whisker.
- 2) Record the length and location (unit#, lead#) of the longest whisker on each lead.
- 3) Take a picture of the longest whisker on each lead for later review.

Criteria: For information only; length [75µm.

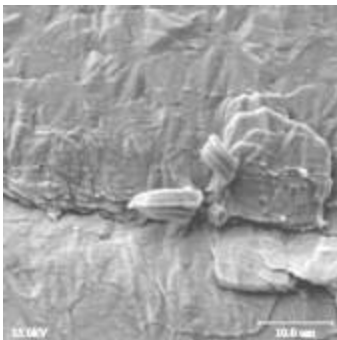
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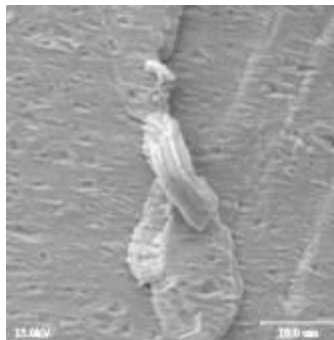
Board-Level Whisker Study, 500 - 55°C/85°C Temp Cycle



- Surface mount does not inhibit whisker growth.
- Whiskers formed on both the plating finish and solder.
- Solder alone does not appear to be prone to whisker growth.



Shoulder- Sn finish/SnAgCu Solder



Foot - SnBi finish/SnAgCu Solder

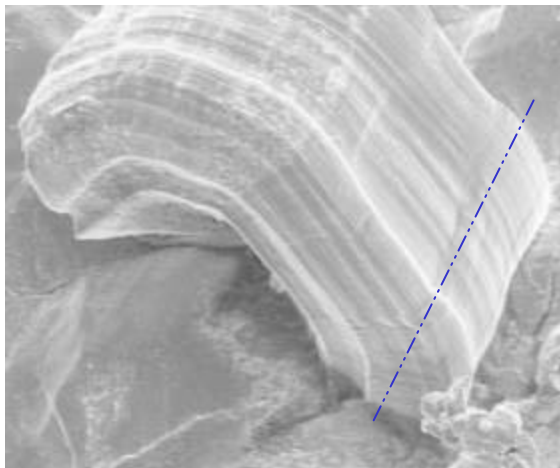


Solder - SnPb finish/SnAgCu Solder

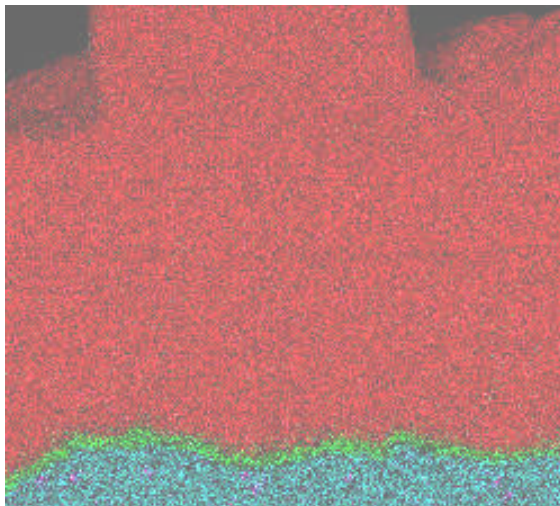
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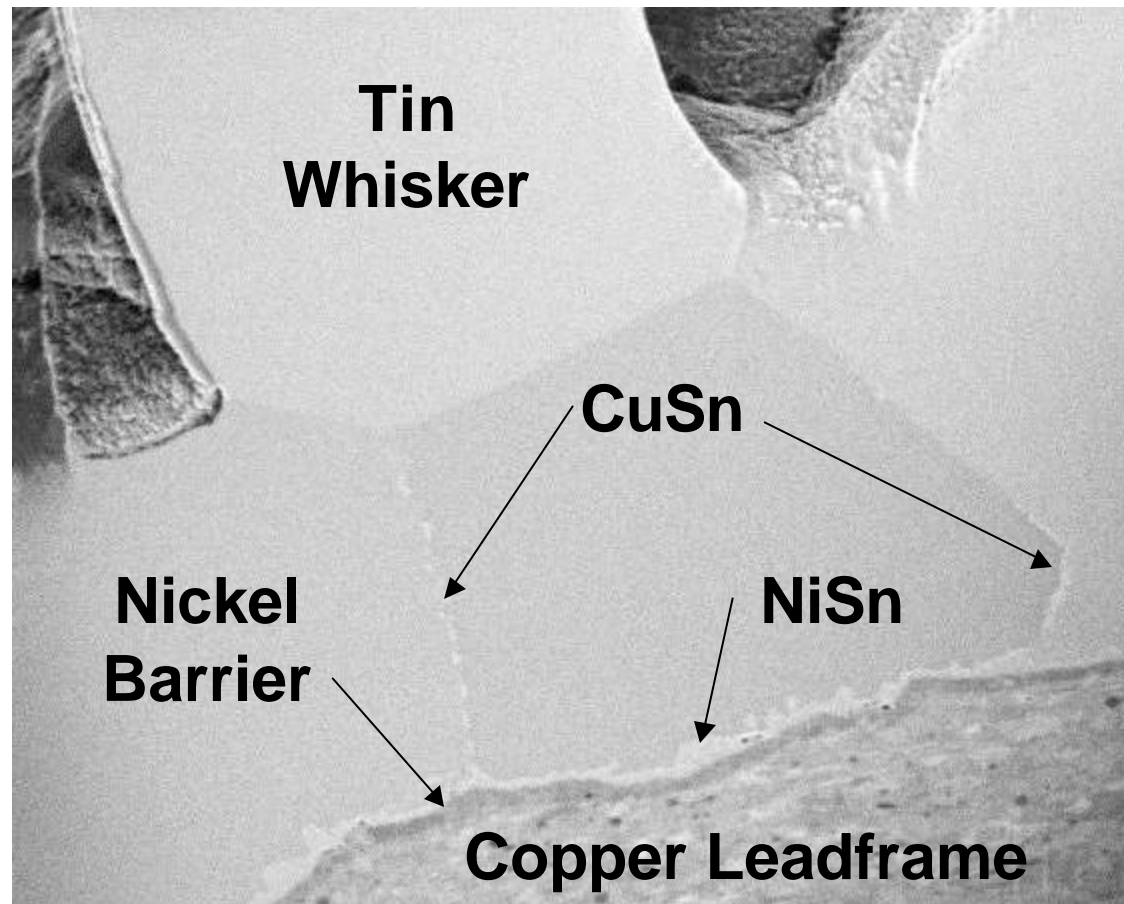
Focused Ion Beam (FIB) of Whisker, Sn with Ni Barrier



Whisker Prior to FIB Cross-Sectioning



EDS Dot Mapping – red is Sn, green is Ni, and blue is Cu



- Whisker appears to form from surface grains.
- Whiskers appear to be made up of only Sn.
- Intermetallics formed between grain boundaries.



-55°C/85°C Temperature Cycle versus Ambient Storage

Package	Plating	Temperature Cycle, -55°C/85°C (500 cycles)		Ambient, ~23°C & ~60%RH (1 Year)	
		Avg. Quantity	Avg. Max. Length	Avg. Quantity	Avg. Max. Length
64 LQFP	Sn	72	15µm	None	N/A
	Sn/2Bi	56	10µm	None	N/A
	Sn/15Pb	1	1µm	None	N/A
132 PQFP	Sn	Not usable	Not usable	Not usable	Not usable
	Sn/2Bi	9	5µm	15	6µm
	Sn/15Pb	None	N/A	None	N/A

- Temperature cycling at -55°C/85°C in general grows more whiskers than storage at ambient (~23°C, ~60%RH).
- Based on the 132PQFP data, whisker growth may be dependent on the plating finish (chemistry, process, composition,...).

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Summary of Findings

- **–55°C/85°C temp cycling and 60°C/95%RH storage accelerated whisker growth.**
- **Whiskers form on Sn-based finishes including SnPb.**
- **Having a Ni barrier did not retard whisker growth.**
- **Whiskers appear to form from surface grains.**
- **SnCu intermetallics formed between grain boundaries and may be a source of internal stress.**
- **Whiskers formed even after surface mount on both package and solder.**
- **Solder itself does not appear to be prone to whisker growth.**
- **500 –55C/85C temp cycles is more severe than one year of storage at ambient.**

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