
WHISKER TEST REPORT (FINAL REPORT)

General Information

Factory	Amkor Technology Philippines – ATP
Plating Finish	Matte Sn
Package Type	TSSOP
Plating Chemistry	ST380
Plating Line	Meco 6
Post Plating Bake	150°C for 1 hour

Report Date : February 1, 2007
Whisker Test Report # : 20060633

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DISCLAIMER. The whisker test procedures identified in this report are used for determining the presence of tin whiskers and are performed by Amkor, pursuant to current industry-accepted JEDEC standards. The whisker test procedures used herein are unproven and may produce inconclusive results. Amkor makes no representation, warranty or guarantee of any kind with respect to the field performance, quality or freedom from whisker-related failures, of any package tested by Amkor using these procedures.

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1. Purpose

1.1. Whisker Test on TSSOP 14lds (C7025 Base Metal) ST380 Chemistry.

2. Scope: Mark (✓) the scope on the following

Process

New plating process	✓
Modified plating process	

Material

New plating material	
Modified plating material	
Alternate source of material	
Alternate manufacturing site of material	

3. Conclusion

3.1. Total # of lots tested : (3) lot(s)

3.2. Comment :

3.2.1. Whisker length measurement method applied for all the whiskers observed was the Radial measurement method. Eighteen (18) terminations per readpoint were SEM inspected and 2 longest whiskers per lot per readpoint were measured and reported. Identified whiskers vary from one readpoint to another since the test objective was to track the longest whisker growth among the samples.

3.2.2. Post 500cyc, 1000cyc, & 1500cyc exposure at -55°C/+85°C TC conditions showed whisker growth in all 3 lots. Longest whiskers observed were:

- TC without precon: comp#2, term#1 with 39.00µm @ 1500cyc;
- TC with 215°C simulated reflow: comp#4, term#2 with 35.01µm @ 1500cyc; and
- TC with 255°C simulated reflow: comp#6, term#11 with 26.42µm @ 1000cyc.

3.2.3. No whisker was observed in all 3 lots after 4000hrs exposure both at 30°C/60%RH and 55°C/85%RH TH conditions.

3.2.4. Twelve (12) terminations with whisker, which were found at the lead tip, have been invalidated after exposure to higher Temperature/Humidity (55°C/85%RH) conditions due to presence of surface corrosion. The invalidation was done per JEDEC Standard JESD201. Other terminations were inspected but no whisker was found. Verification results were detailed at the end of report under Appendix 5.4.3.

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4. Package / Material Description

4.1. Package

Type	TSSOP
Body size	4.4 mm
Lead Count	14L
Lead Pitch	0.65 mm
Lead to Lead Gap	NP

4.2. Material

Lead frame	
Base metal alloy	C7025
Temper (1/2 hard, etc.)	Full Hard
Stamped/Etched L/F	Etched
L/F thickness	6 mils
Barrier layer type	Pure Tin Over Copper
Barrier layer thickness	N/A

4.3. Process Dates

	Lot #1	Lot #2	Lot #3
Plating date/time	05/10/06 / 1020H	05/17/06 / 1115H	05/24/06 / 1330H
Post bake date/time	05/10/06 / 1045H	05/17/06 / 1130H	05/24/06 / 1355H
Simulated reflow date	07/12/06	07/12/06	07/12/06
Board assembly date	N/A	N/A	N/A
30°C/60%RH start date	07/12/06	07/12/06	07/12/06
55°C/85%RH start date	07/12/06	07/12/06	07/12/06
-55°C/85°C start date	07/12/06	07/12/06	07/12/06

5. Attachments

- 5.1. Process Summary
- 5.2. Workmanship Summary
- 5.3. Whisker Test Summary and Photos
- 5.4. Appendix

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5.1. Process Summary

Lot# : LOT-1

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	Belt Speed Descale <ul style="list-style-type: none"> • Temperature • Concentration – Salt • Concentration – Acid Plating <ul style="list-style-type: none"> • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Primary • Concentration – Secondary • Bath Temperature Impurities <ul style="list-style-type: none"> • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn⁺⁴ 	8 m/min 35°C 74.70 g/li NA 121.70 ASF 200 amps/cell 272.50 ml/li 78.90 g/li N/A N/A 71.70 ml/li 3.00 ml/li 28°C 0.01225 % wt 3.90 ppm 2.69 ppm 8.77 ppm 14.23 ppm 1.56 %	Descale Solution	Actronal 988
Post Plating Bake	Yamato	Hold Temperature Dwell Time Total Cycle Time	150°C 1 hr 1.5 hr		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature Dwell Time > 183°C	218°C 60 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	260°C 75 seconds		

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Lot# : LOT-2

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	Belt Speed Descale <ul style="list-style-type: none"> • Temperature • Concentration – Salt • Concentration – Acid Plating <ul style="list-style-type: none"> • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Primary • Concentration – Secondary • Bath Temperature Impurities <ul style="list-style-type: none"> • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn⁺⁴ 	8 m/min 35°C 77.50 g/li NA 121.70 ASF 200 amps/cell 270.50 ml/li 74.00 g/li N/A N/A 79.90 ml/li 3.30 ml/li 28°C 0.01225 % wt 3.73 ppm 6.84 ppm 19.81 ppm 5.65 ppm 1.56 %	Descale Solution	Actronal 988
Post Plating Bake	Yamato	Hold Temperature Dwell Time Total Cycle Time	150°C 1 hr 1.5 hr		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature Dwell Time > 183°C	218°C 60 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	260°C 75 seconds		

WHISKER TEST REPORT (FINAL REPORT)

Lot# : LOT-3

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	Belt Speed Descale • Temperature • Concentration – Salt • Concentration – Acid Plating • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Primary • Concentration – Secondary • Bath Temperature Impurities • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn ⁺⁴	8 m/min 35°C 80.70 g/li NA 121.70 ASF 200 amps/cell 272.50 ml/li 80.40 g/li N/A N/A 78.00 ml/li 3.10 ml/li 28°C 0.01225 % wt 4.91 ppm 6.84 ppm 19.81 ppm 5.65 ppm 2.84 %	Descale Solution	Actronal 988
Post Plating Bake	Yamato	Hold Temperature Dwell Time Total Cycle Time	150°C 1 hr 1.5 hr		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature Dwell Time > 183°C	218°C 60 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	260°C 75 seconds		

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5.2. Plating Workmanship Summary

Lot# : LOT-1

Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/116	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10 – 17.50µm)	0/5 rdgs	579.30	510.20	552.80	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	2.31	2.15	2.22	

Lot# : LOT-2

Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/116	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10 – 17.50µm)	0/5 rdgs	577.20	513.80	551.50	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	2.54	2.36	2.45	

Lot# : LOT-3

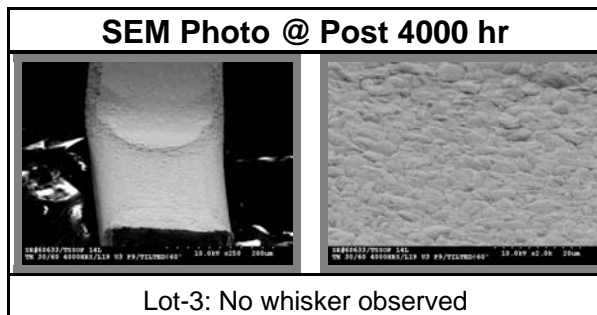
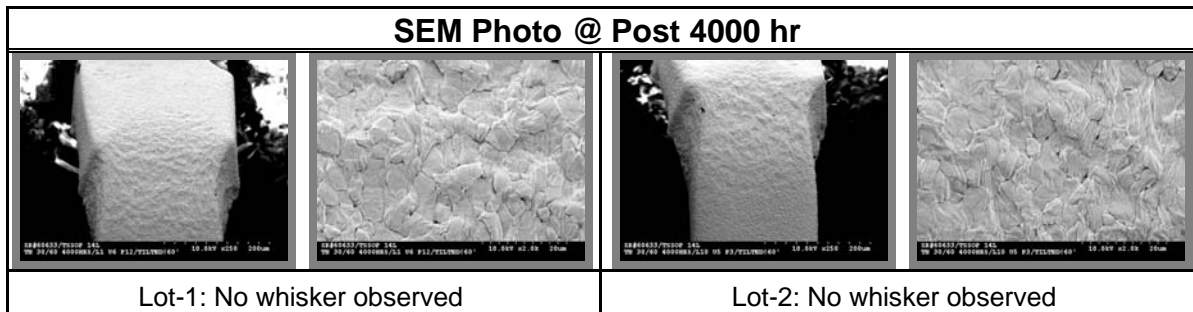
Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/116	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10 – 17.50µm)	0/5 rdgs	580.10	517.20	550.90	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	2.56	2.15	2.34	

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5.3. Whisker Test Summary

5.3.1. Ambient Temperature/Humidity (30°C/60%RH)

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>6</u> / Term # <u>12</u>	none	none	none	none	none
Lot-2	Comp # <u>5</u> / Term # <u>3</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>9</u>	none	none	none	none	none

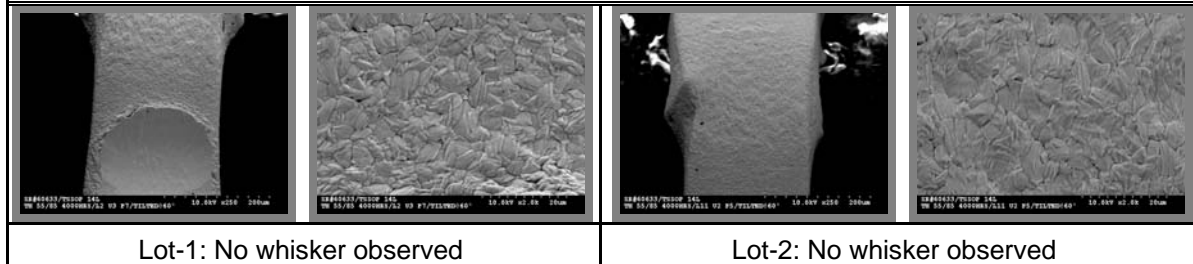


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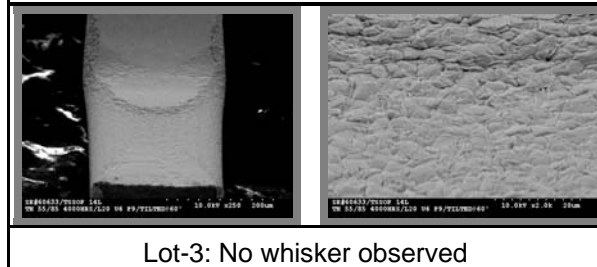
5.3.2. High Temperature/Humidity (55°C/85%RH)

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>3</u> / Term # <u>7</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>5</u>	none	none	none	none	none
Lot-3	Comp # <u>6</u> / Term # <u>9</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr






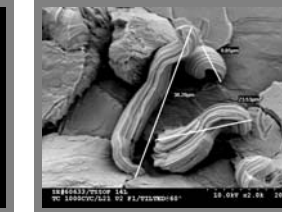
SEM Photo @ Post 4000 hr

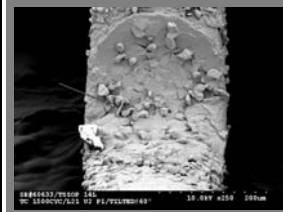



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5.3.3. Thermal Cycling (-55/85°C)

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>2</u> / Term # <u>6</u>	none	19.22µm	24.86µm	26.50µm
	Comp # <u>3</u> / Term # <u>2</u>	none	22.03µm	23.42µm	32.60µm
Lot-2	Comp # <u>1</u> / Term # <u>2</u>	none	24.16µm	27.52µm	28.77µm
	Comp # <u>2</u> / Term # <u>2</u>	none	17.19µm	-	-
	Comp # <u>2</u> / Term # <u>8</u>	none	-	23.08µm	-
	Comp # <u>3</u> / Term # <u>2</u>	none	-	-	28.42µm
Lot-3	Comp # <u>1</u> / Term # <u>1</u>	none	24.40µm	-	-
	Comp # <u>3</u> / Term # <u>4</u>	none	30.31µm	32.46µm	34.61µm
	Comp # <u>2</u> / Term # <u>1</u>	none	-	38.28µm	39.00µm

SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 30.31µm		Longest whisker growth of 38.28µm	

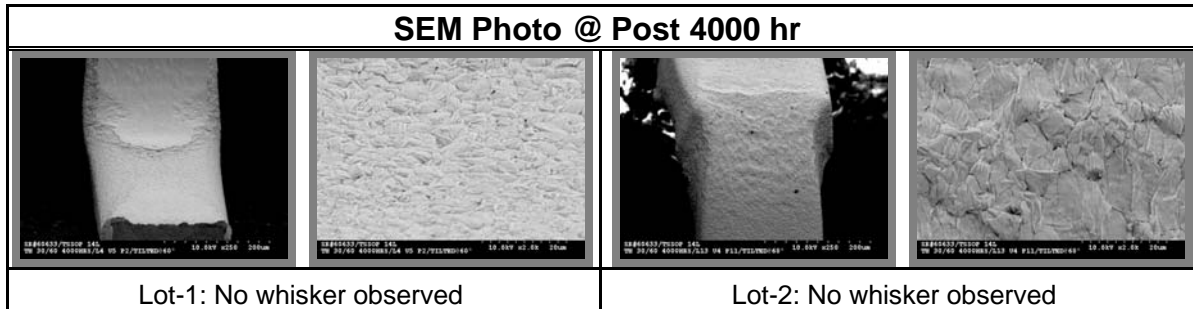
SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 39.00µm	

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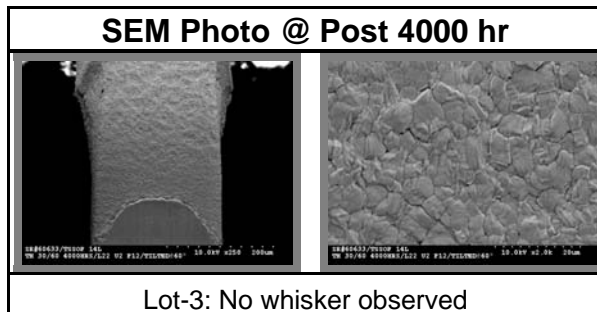
5.3.4. Ambient Temperature/Humidity (30°C/60%RH) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>5</u> / Term # <u>2</u>	none	none	none	none	none
Lot-2	Comp # <u>4</u> / Term # <u>11</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>12</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr



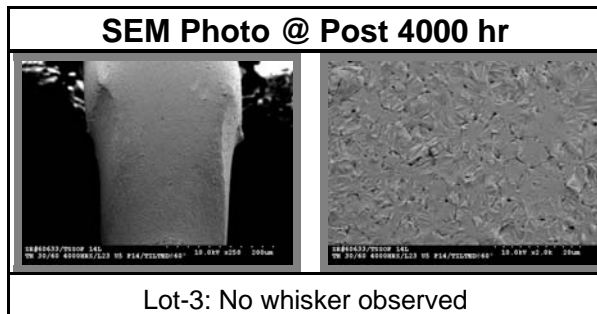
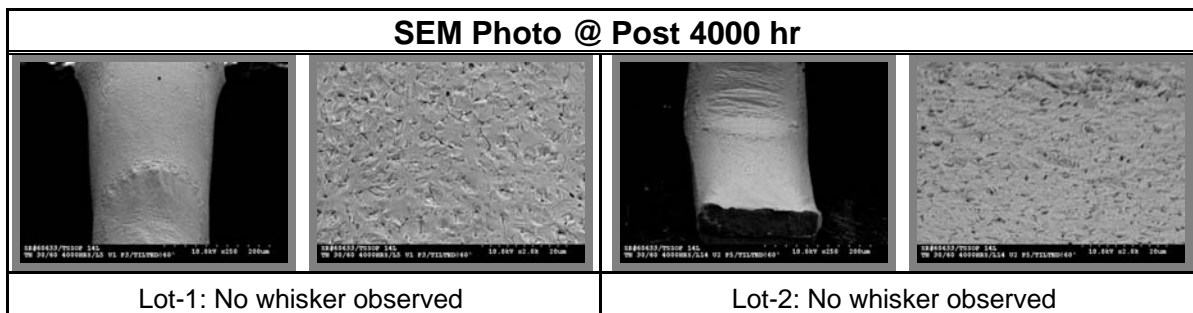
SEM Photo @ Post 4000 hr



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5.3.5. Ambient Temperature/Humidity (30°C/60%RH) post 255°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>3</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>5</u>	none	none	none	none	none
Lot-3	Comp # <u>5</u> / Term # <u>14</u>	none	none	none	none	none

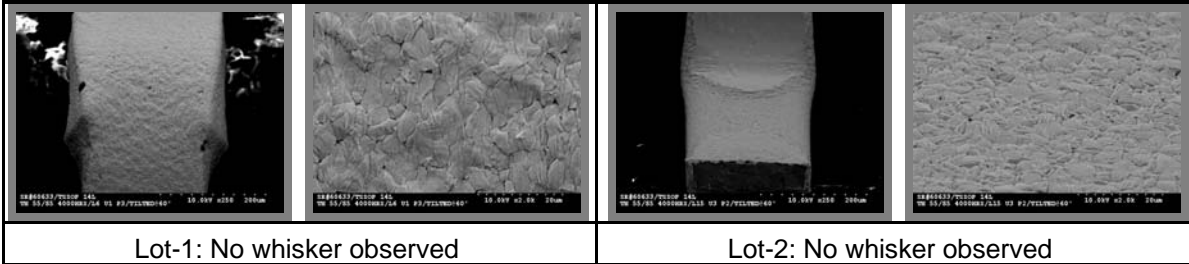


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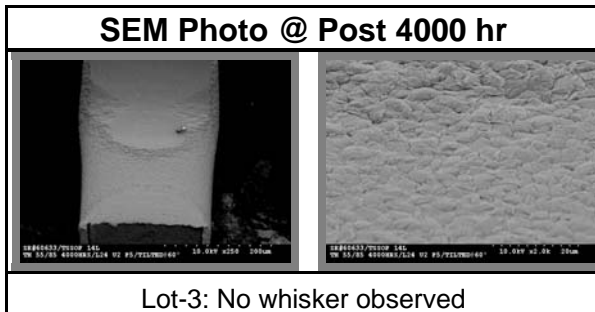
5.3.6. High Temperature/Humidity (55°C/85%RH) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>3</u>	none	none	none	none	none
Lot-2	Comp # <u>3</u> / Term # <u>2</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>5</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr



SEM Photo @ Post 4000 hr

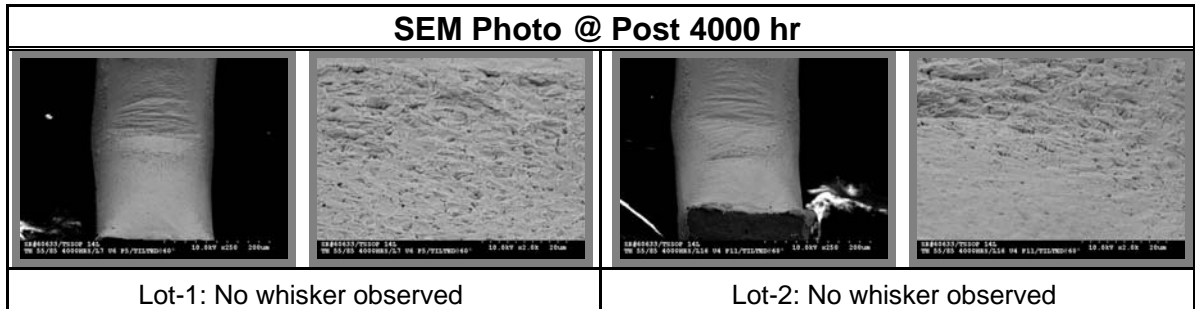


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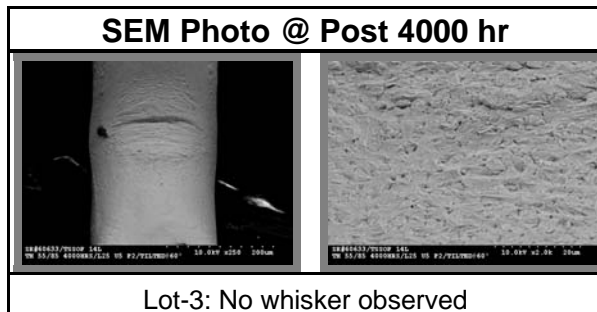
5.3.7. High Temperature/Humidity (55°C/85%RH) post 255°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3312 hr	4000 hr
Lot-1	Comp # <u>6</u> / Term # <u>5</u>	none	none	none	none	none
Lot-2	Comp # <u>4</u> / Term # <u>11</u>	none	none	none	none	none
Lot-3	Comp # <u>5</u> / Term # <u>2</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr



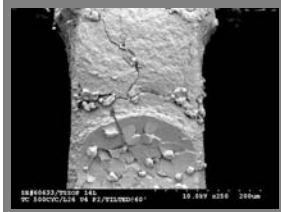

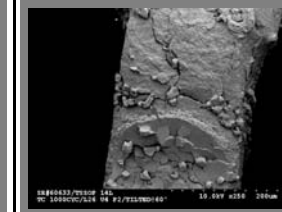

SEM Photo @ Post 4000 hr

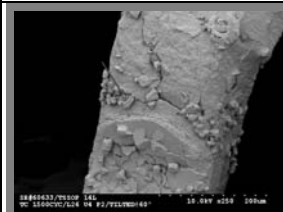
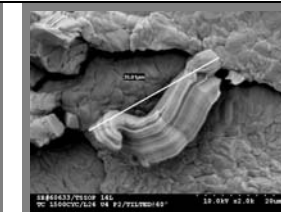


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5.3.8. Thermal Cycling (-55/85°C) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>4</u> / Term # <u>4</u>	none	22.91µm	23.41µm	27.30µm
	Comp # <u>6</u> / Term # <u>4</u>	none	20.04µm	-	-
	Comp # <u>1</u> / Term # <u>1</u>	none	-	28.02µm	29.10µm
Lot-2	Comp # <u>4</u> / Term # <u>8</u>	none	18.27µm	-	-
	Comp # <u>5</u> / Term # <u>4</u>	none	19.20µm	22.55µm	23.22µm
	Comp # <u>4</u> / Term # <u>7</u>	none	-	21.86µm	-
	Comp # <u>4</u> / Term # <u>6</u>	none	-	-	23.25µm
Lot-3	Comp # <u>4</u> / Term # <u>2</u>	none	32.87µm	34.97µm	35.01µm
	Comp # <u>5</u> / Term # <u>5</u>	none	21.48µm	34.83µm	34.91µm


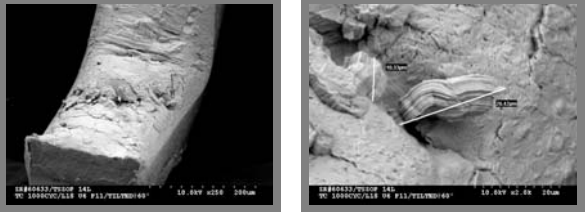
SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 32.87µm		Longest whisker growth of 34.97µm	

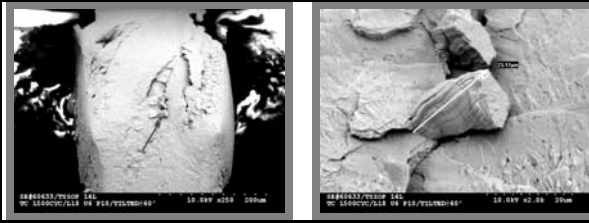
SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 35.01µm	

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5.3.9. Thermal Cycling (-55/85°C) post 255°C simulated reflow

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>1</u> / Term # <u>1</u>	none	15.04µm	15.38µm	16.16µm
	Comp # <u>3</u> / Term # <u>10</u>	none	12.85µm	-	-
	Comp # <u>3</u> / Term # <u>15</u>	none	-	17.21µm	-
	Comp # <u>3</u> / Term # <u>14</u>	none	-	-	20.69µm
Lot-2	Comp # <u>1</u> / Term # <u>4</u>	none	12.03µm	-	-
	Comp # <u>6</u> / Term # <u>11</u>	none	20.54µm	26.42µm	22.46µm
	Comp # <u>6</u> / Term # <u>10</u>	none	-	13.47µm	23.17µm
Lot-3	Comp # <u>1</u> / Term # <u>2</u>	none	14.58µm	20.40µm	21.09µm
	Comp # <u>6</u> / Term # <u>14</u>	none	13.27µm	17.08µm	18.27µm

SEM Photo @ Post 500 cyc	SEM Photo @ Post 1000 cyc
 <p>Longest whisker growth of 20.54µm</p>	 <p>Longest whisker growth of 26.42µm</p>

SEM Photo @ Post 1500 cyc
 <p>Longest whisker growth of 23.17µm</p>

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5.4. Appendix

5.4.1. Inspection Equipment

5.4.1.1. Optical Microscope

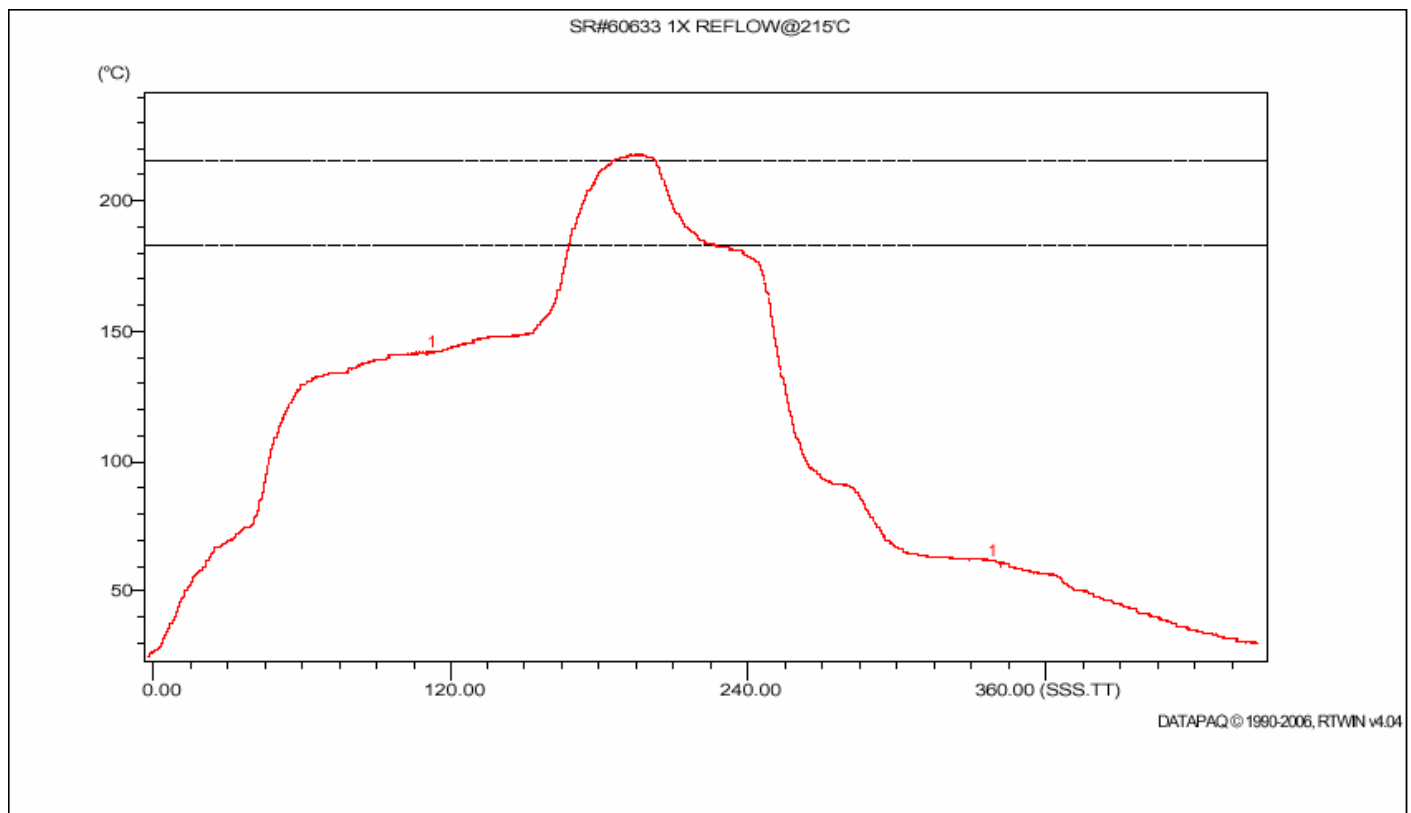
Instrument maker : Olympus
Model number : SZ40
Magnification : 40-60x

5.4.1.2. SEM

Instrument maker : Hitachi
Model number : S3000N
Magnification : 500kx

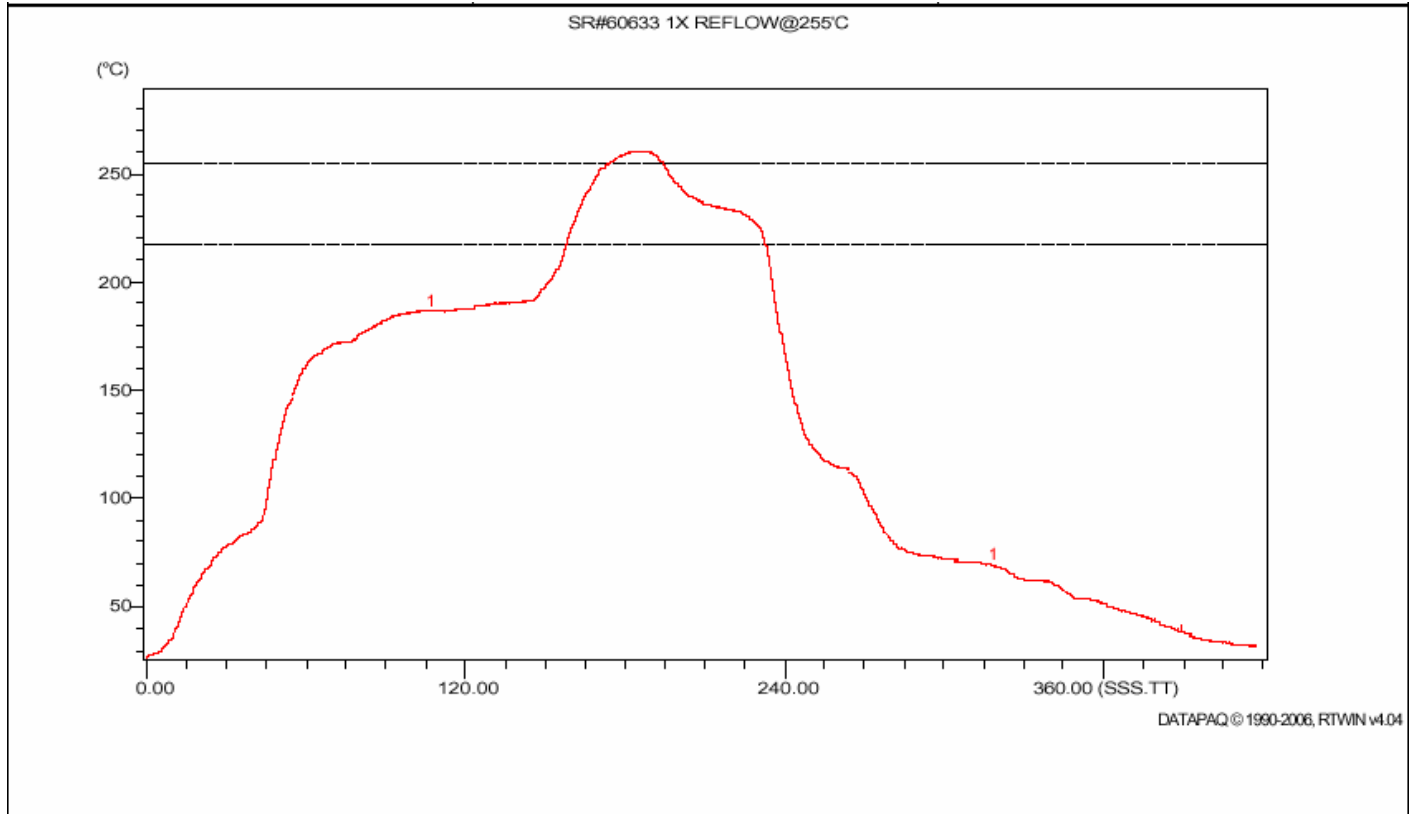
5.4.2. Reflow Profiles

5.4.2.1. Simulated 215°C Reflow



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5.4.2.2. Simulated 255°C Reflow



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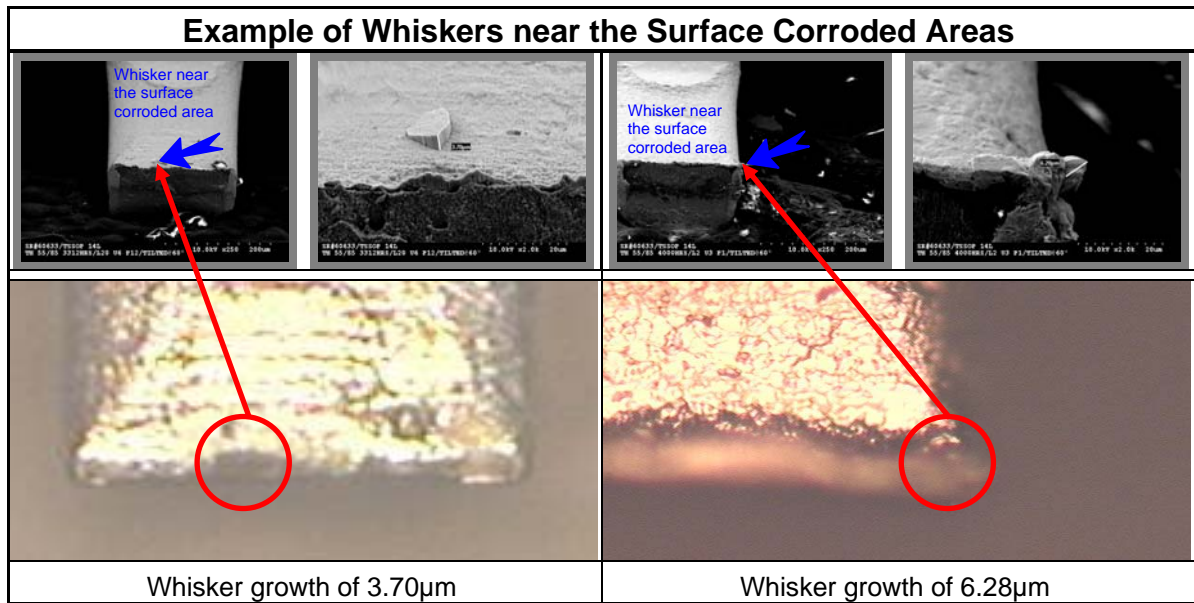
5.4.3. Verification Results of Terminations with Surface Corrosion

5.4.3.1. Surface Corrosion Definition from JEDEC Standard JESD201

Surface Corrosion: A localized change to a silver-colored Sn surface finish appearing in an optical microscope as non-reflective dark spots ranging in size from about 25 micrometers on the longest dimension to the entire termination.

5.4.3.2. Verification of Surface Corrosion at different High Temperature/Humidity Conditions

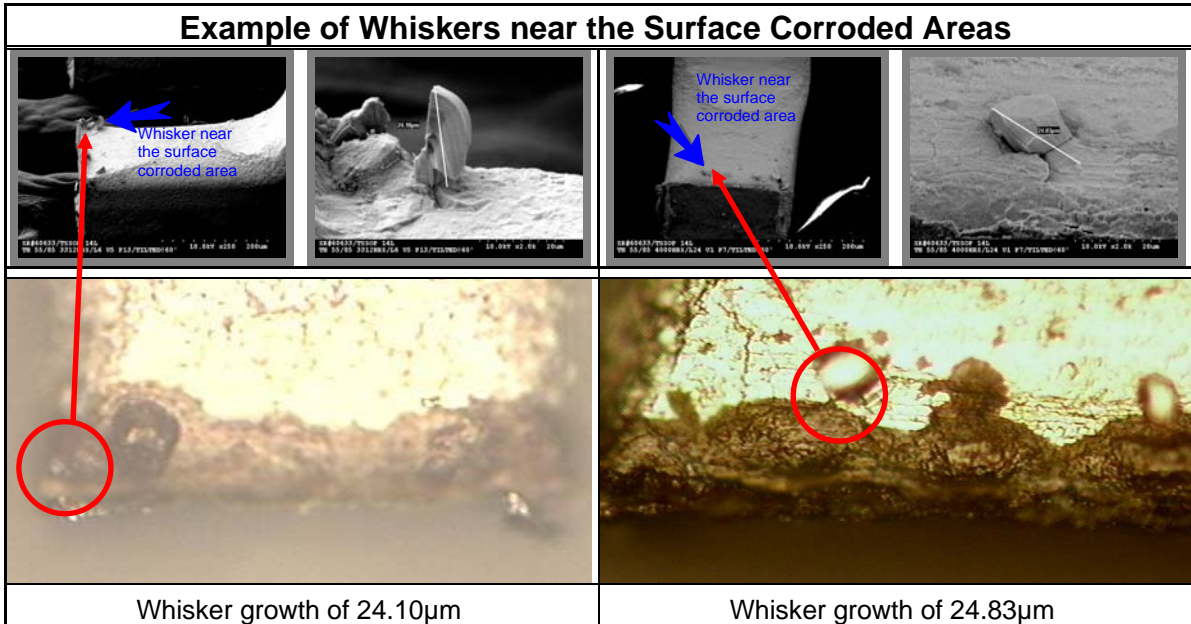
5.4.3.2.1. High Temperature/Humidity (55°C/85%RH)



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5.4.3.2.2. High Temperature/Humidity (55°C/85%RH) post 215°C simulated reflow

Example of Whiskers near the Surface Corroded Areas



Whisker growth of 24.10µm

Whisker growth of 24.83µm