
WHISKER TEST REPORT (FINAL REPORT)

General Information

Factory	Amkor Technology Philippines – P1-1
Plating Finish	Matte Sn
Package Type	TQFP
Plating Chemistry	ST380
Plating Line	T4B
Post Plating Bake	150°C for 1 hour

Report Date : March 30, 2006
Whisker Test Report # : 20050876

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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 TQFP 44lds (EFTEC 64 Base Metal) ST380 Chemistry – Select Qual Level B.

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 lot per readpoint were SEM inspected and minimum of 2 longest whiskers per lot per readpoint were 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#5 with 33.93µm @ 1500cyc;
 - TC with 215°C simulated reflow: comp#2, term#23 with 30.50µm @ 1000cyc; and
 - TC with 255°C simulated reflow: comp#5, term#16 with 28.24µm @ 1500cyc.
- 3.2.3. No whisker was observed in all 3 lots after 4000hrs exposure both at 30°C/60%RH and 60°C/87%RH TH conditions.
- 3.2.4. Thirty-four (34) terminations with whiskers, which were all found at the lead tip, have been invalidated after exposure to higher Temperature/Humidity (60°C/87%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	TQFP
Body size	10x10 mm
Lead Count	44L
Lead Pitch	0.80 mm
Lead to Lead Gap	0.35 mm

4.2. Material

Lead frame	
Base metal alloy	EFTEC 64
Temper (½ hard, etc.)	½ hard
Stamped/Etched L/F	STAMPED
L/F thickness	0.127 +/- 0.3 mm
Barrier layer type	N/A
Barrier layer thickness	N/A

4.3. Process Dates

	Lot #1	Lot #2	Lot #3
Plating date/time	6/23/05 / 2130H	6/24/05 / 1220H	6/24/05 / 1510H
Post bake date/time	6/24/05 / 0931H	6/24/05 / 1650H	6/24/05 / 1625H
Simulated reflow date	7/15/05	7/15/05	7/15/05
Board assembly date	N/A	N/A	N/A
30°C/60%RH start date	7/18/05	7/18/05	7/18/05
60°C/87%RH start date	7/18/05	7/18/05	7/18/05
-55°C/85°C start date	7/16/05	7/16/05	7/16/05

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	Technic	Descale Temperature	35°C	Descale Solution	Actronal 988
		Belt Speed	75 mm/sec		
		Current Density	148.82 ASF		
		[Sn metal]	69 g/l		
		[Bi metal] (if applicable)	N/A		
		Bath Temperature	28°C		
		Bath Impurities			
		• Pb	7.6 ppm		
		• Cu	0.4 ppm		
		• Fe	29.2 ppm		
		• Ni	1.6 ppm		
		• Zn	0.3 ppm		
		• Ag	0.8 ppm		
Post Plating Bake	Yamato	Hold Temperature	150°C		
		Dwell Time	60 minutes		
		Total Cycle Time	120 minutes		
		N ₂ Gas Flow Rate	200 SCFH		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature	215°C		
		Dwell Time > 183°C	71 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature	256°C		
		Dwell Time > 217°C	73 seconds		

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Lot# : LOT-2

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Technic	Descale Temperature	35°C	Descale Solution	Actronal 988
		Belt Speed	75 mm/sec		
		Current Density	148.82 ASF		
		[Sn metal]	70 g/l		
		[Bi metal] (if applicable)	N/A		
		Bath Temperature	28°C		
		Bath Impurities			
		• Pb	7.6 ppm		
		• Cu	0.4 ppm		
		• Fe	29.2 ppm		
		• Ni	1.6 ppm		
		• Zn	0.3 ppm		
		• Ag	0.8 ppm		
Post Plating Bake	Yamato	Hold Temperature	150°C		
		Dwell Time	60 minutes		
		Total Cycle Time	120 minutes		
		N ₂ Gas Flow Rate	200 SCFH		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature	215°C		
		Dwell Time > 183°C	71 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature	256°C		
		Dwell Time > 217°C	73 seconds		

WHISKER TEST REPORT (FINAL REPORT)

Lot# : LOT-3

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Technic	Descale Temperature	35°C	Descale Solution	Actronal 988
		Belt Speed	75 mm/sec		
		Current Density	148.82 ASF		
		[Sn metal]	70 g/l		
		[Bi metal] (if applicable)	N/A		
		Bath Temperature	28°C		
		Bath Impurities			
		• Pb	7.6 ppm		
		• Cu	0.4 ppm		
		• Fe	29.2 ppm		
		• Ni	1.6 ppm		
		• Zn	0.3 ppm		
		• Ag	0.8 ppm		
Post Plating Bake	Yamato	Hold Temperature	150°C		
		Dwell Time	60 minutes		
		Total Cycle Time	120 minutes		
		N ₂ Gas Flow Rate	200 SCFH		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature	215°C		
		Dwell Time > 183°C	71 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature	256°C		
		Dwell Time > 217°C	73 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	STD	Cpk	
001-0530-2011	Visual	001-0322-2595	0/116 units	N/A	N/A	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10.0 – 17.5µm)	0/5 strips	558.6	497.6	522.4	14.3	2.9	PASSED
001-0522-2571	Deposit composition	100% Sn	5 rdgs	N/A	N/A	N/A	N/A	N/A	100% Sn
001-0234-2057	Carbon content	0.05% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.00963% wt
	Deposit impurities - Pb	0.1% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.0105% wt
Stripping method	Grain size range	N/A	0/4 rdgs	4.6	3.2	4.2	N/A	N/A	

Lot# : LOT-2

Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data					Result
				MAX	MIN	AVG	STD	Cpk	
001-0530-2011	Visual	001-0322-2595	0/116 units	N/A	N/A	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10.0 – 17.5µm)	0/5 strips	578.6	504.7	545.4	23.7	1.9	PASSED
001-0522-2571	Deposit composition	100% Sn	5 rdgs	N/A	N/A	N/A	N/A	N/A	100% Sn
001-0234-2057	Carbon content	0.05% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.00963% wt
	Deposit impurities - Pb	0.1% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.0105% wt
Stripping method	Grain size range	N/A	0/4 rdgs	4.7	3.1	3.9	N/A	N/A	

Lot# : LOT-3

Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data					Result
				MAX	MIN	AVG	STD	Cpk	
001-0530-2011	Visual	001-0322-2595	0/116 units	N/A	N/A	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10.0 – 17.5µm)	0/5 strips	565.3	485.6	536.3	25.3	1.9	PASSED
001-0522-2571	Deposit composition	100% Sn	5 rdgs	N/A	N/A	N/A	N/A	N/A	100% Sn
001-0234-2057	Carbon content	0.05% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.00963% wt
	Deposit impurities - Pb	0.1% max.	N/A	N/A	N/A	N/A	N/A	N/A	0.0105% wt
Stripping method	Grain size range	N/A	0/4 rdgs	4.5	2.7	3.8	N/A	N/A	

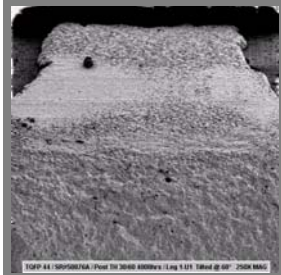
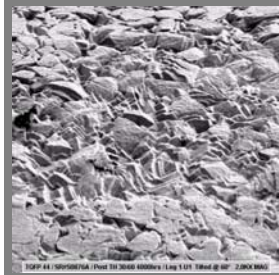
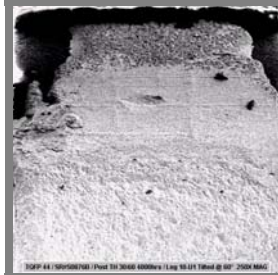
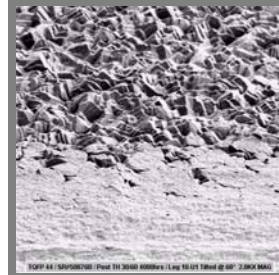
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5.3. Whisker Test Summary

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

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>1</u>	none	none	none	none	none
Lot-2	Comp # <u>1</u> / Term # <u>12</u>	none	none	none	none	none
Lot-3	Comp # <u>1</u> / Term # <u>30</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr

			
Lot-1: No whisker observed		Lot-2: No whisker observed	

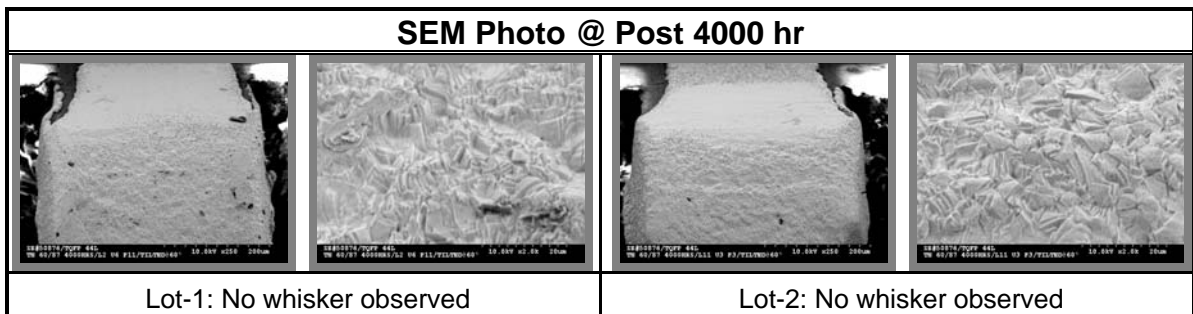
SEM Photo @ Post 4000 hr

	
Lot-3: No whisker observed	

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5.3.2. High Temperature/Humidity (60°C/87%RH)

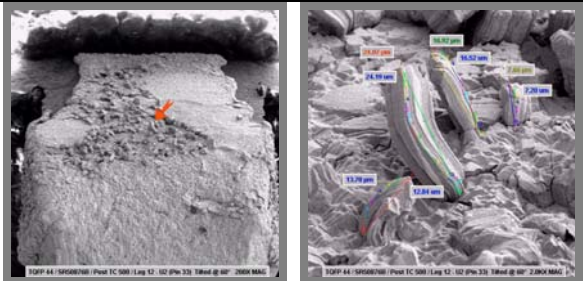
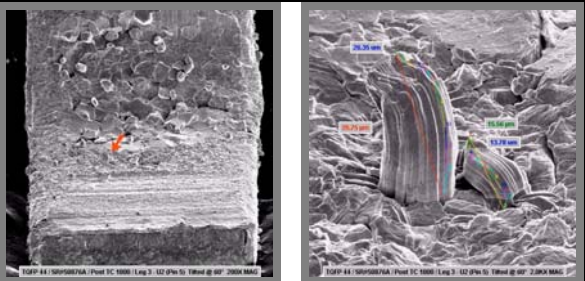
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>6</u> / Term # <u>11</u>	none	none	none	none	none
Lot-2	Comp # <u>3</u> / Term # <u>3</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>10</u>	none	none	none	none	none

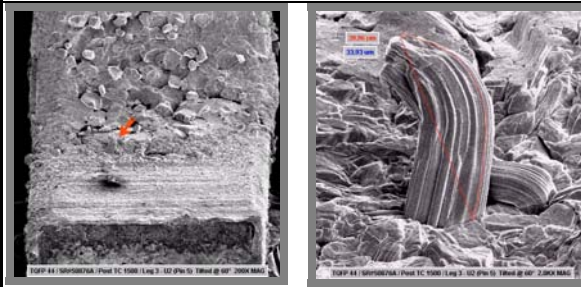


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5.3.3. Thermal Cycling (-55/85°C)

Lot No.	Component # / Termination #	Readpoints			
		0 hr	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>1</u> / Term # <u>1</u>	none	14.93µm	19.74µm	-
	Comp # <u>2</u> / Term # <u>5</u>	none	19.63µm	26.35µm	33.93µm
	Comp # <u>3</u> / Term # <u>15</u>	none	21.03µm	23.23µm	22.53µm
	Comp # <u>1</u> / Term # <u>7</u>	none	-	-	25.59µm
Lot-2	Comp # <u>1</u> / Term # <u>2</u>	none	14.85µm	16.30µm	19.11µm
	Comp # <u>2</u> / Term # <u>33</u>	none	24.19µm	24.16µm	24.58µm
	Comp # <u>5</u> / Term # <u>1</u>	none	17.85µm	23.44µm	24.52µm
Lot-3	Comp # <u>1</u> / Term # <u>2</u>	none	16.42µm	17.94µm	18.09µm
	Comp # <u>2</u> / Term # <u>23</u>	none	12.39µm	16.08µm	20.93µm
	Comp # <u>5</u> / Term # <u>1</u>	none	13.69µm	14.05µm	13.23µm

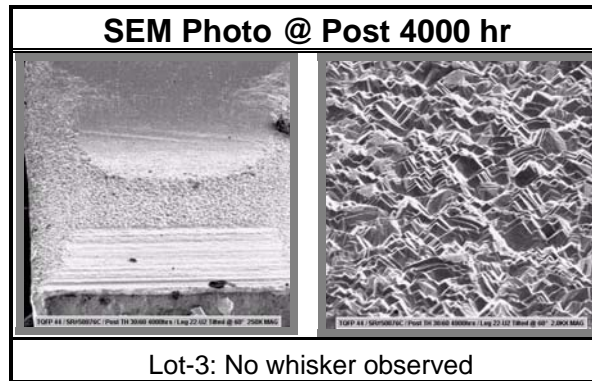
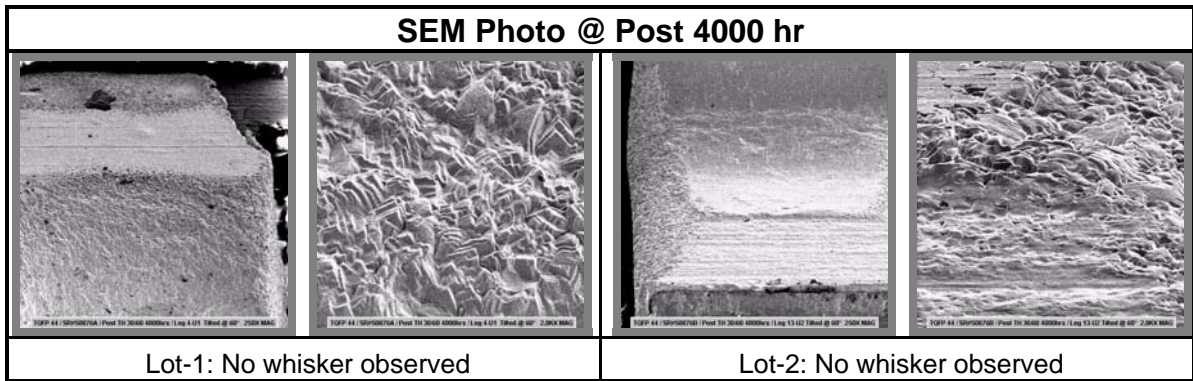
SEM Photo @ Post 500 cyc	SEM Photo @ Post 1000 cyc
 <p>Longest whisker growth of 24.19µm</p>	 <p>Longest whisker growth of 26.35µm</p>

SEM Photo @ Post 1500 cyc
 <p>Longest whisker growth of 33.93µm</p>

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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	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>5</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>17</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>25</u>	none	none	none	none	none

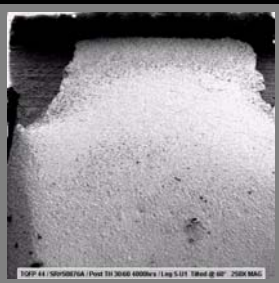
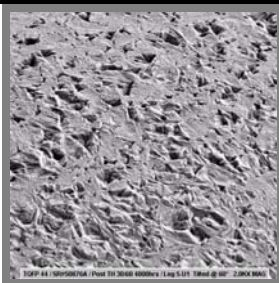


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5.3.5. Ambient Temperature/Humidity (30°C/60%RH) post 255°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>9</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>17</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>40</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr

 Lot-1: No whisker observed	 Lot-2: No whisker observed
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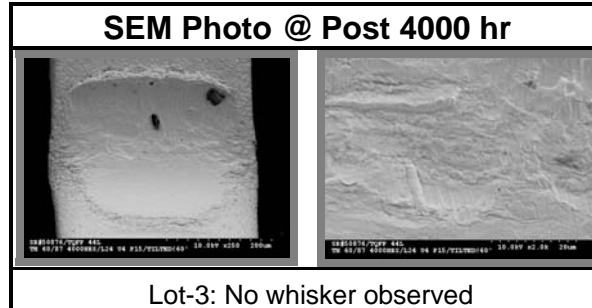
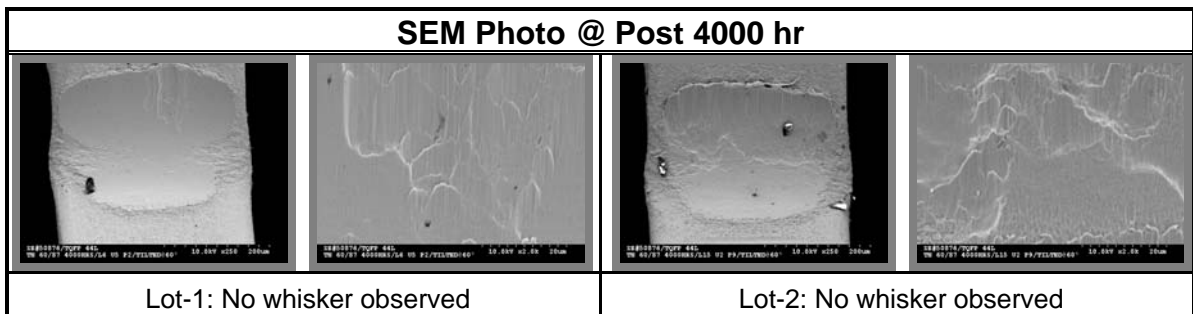
SEM Photo @ Post 4000 hr

 Lot-3: No whisker observed

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5.3.6. High Temperature/Humidity (60°C/87%RH) post 215°C simulated reflow

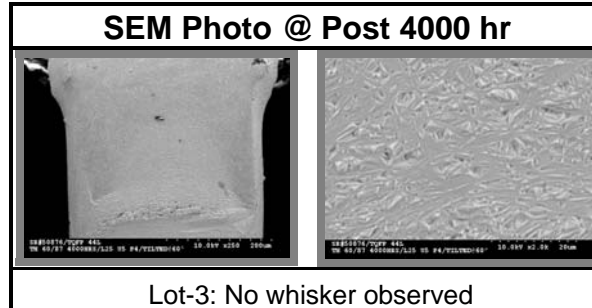
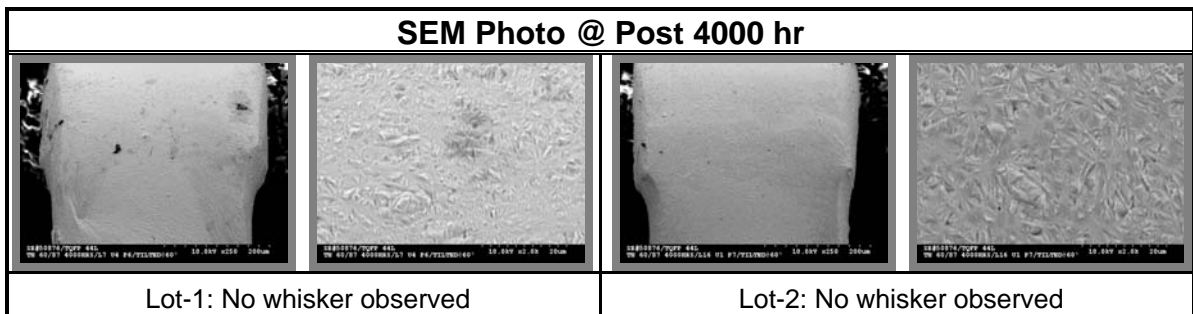
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>5</u> / Term # <u>2</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>9</u>	none	none	none	none	none
Lot-3	Comp # <u>4</u> / Term # <u>15</u>	none	none	none	none	none



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5.3.7. High Temperature/Humidity (60°C/87%RH) post 255°C simulated reflow

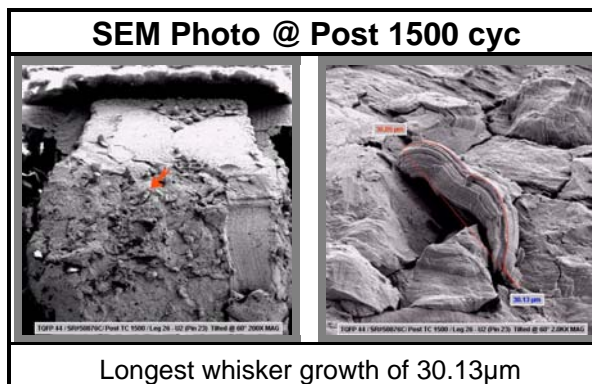
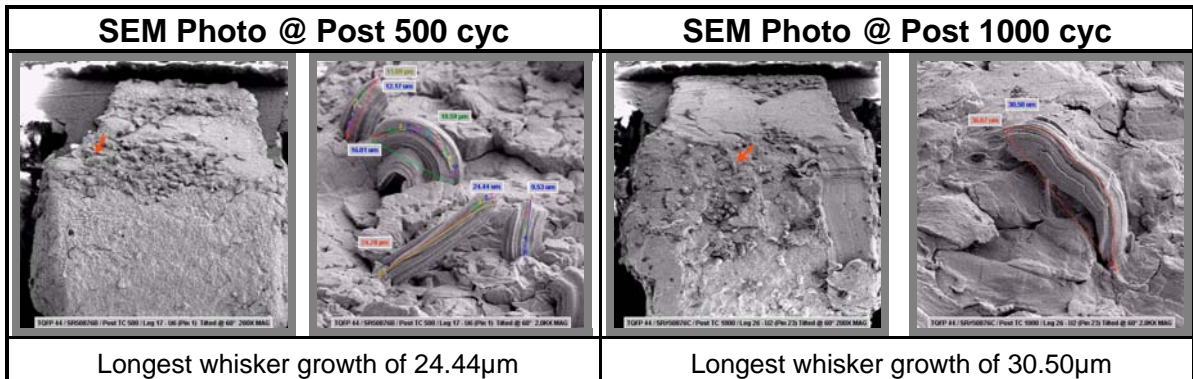
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>4</u> / Term # <u>6</u>	none	none	none	none	none
Lot-2	Comp # <u>1</u> / Term # <u>7</u>	none	none	none	none	none
Lot-3	Comp # <u>5</u> / Term # <u>4</u>	none	none	none	none	none



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

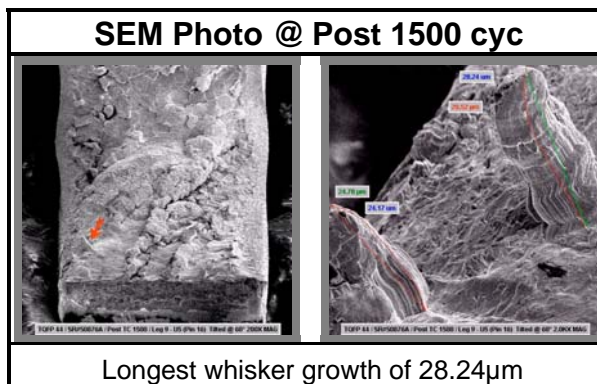
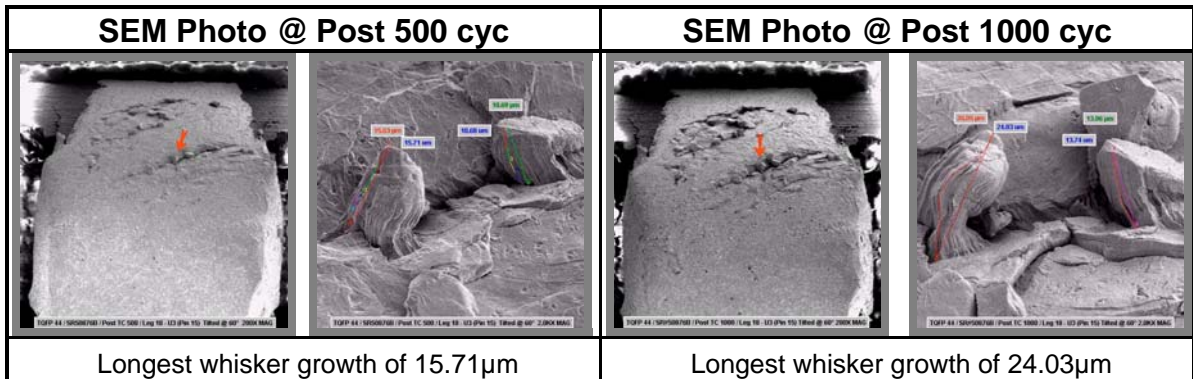
Lot No.	Component # / Termination #	Readpoints			
		0 hr	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>1</u> / Term # <u>27</u>	none	18.84µm	21.91µm	22.76µm
	Comp # <u>2</u> / Term # <u>1</u>	none	18.02µm	19.12µm	21.28µm
	Comp # <u>3</u> / Term # <u>38</u>	none	16.04µm	22.10µm	25.18µm
Lot-2	Comp # <u>1</u> / Term # <u>5</u>	none	16.34µm	16.37µm	22.39µm
	Comp # <u>3</u> / Term # <u>5</u>	none	19.43µm	20.67µm	18.17µm
	Comp # <u>6</u> / Term # <u>1</u>	none	24.44µm	26.42µm	21.35µm
Lot-3	Comp # <u>1</u> / Term # <u>38</u>	none	16.29µm	18.73µm	23.85µm
	Comp # <u>2</u> / Term # <u>23</u>	none	24.24µm	30.50µm	30.13µm
	Comp # <u>5</u> / Term # <u>26</u>	none	16.39µm	18.19µm	16.35µm



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

Lot No.	Component # / Termination #	Readpoints			
		0 hr	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>2</u> / Term # <u>21</u>	none	10.99µm	14.45µm	15.41µm
	Comp # <u>3</u> / Term # <u>31</u>	none	11.23µm	13.09µm	13.57µm
	Comp # <u>5</u> / Term # <u>16</u>	none	14.78µm	23.06µm	28.24µm
Lot-2	Comp # <u>2</u> / Term # <u>13</u>	none	7.50µm	13.88µm	13.49µm
	Comp # <u>3</u> / Term # <u>15</u>	none	15.71µm	24.03µm	23.61µm
	Comp # <u>6</u> / Term # <u>12</u>	none	9.32µm	15.58µm	16.09µm
Lot-3	Comp # <u>1</u> / Term # <u>13</u>	none	15.08µm	13.39µm	19.68µm
	Comp # <u>2</u> / Term # <u>38</u>	none	15.28µm	15.25µm	14.00µm
	Comp # <u>3</u> / Term # <u>43</u>	none	13.97µm	15.70µm	16.60µm



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5.4. Appendix

5.4.1. Inspection Equipment

5.4.1.1. Optical Microscope

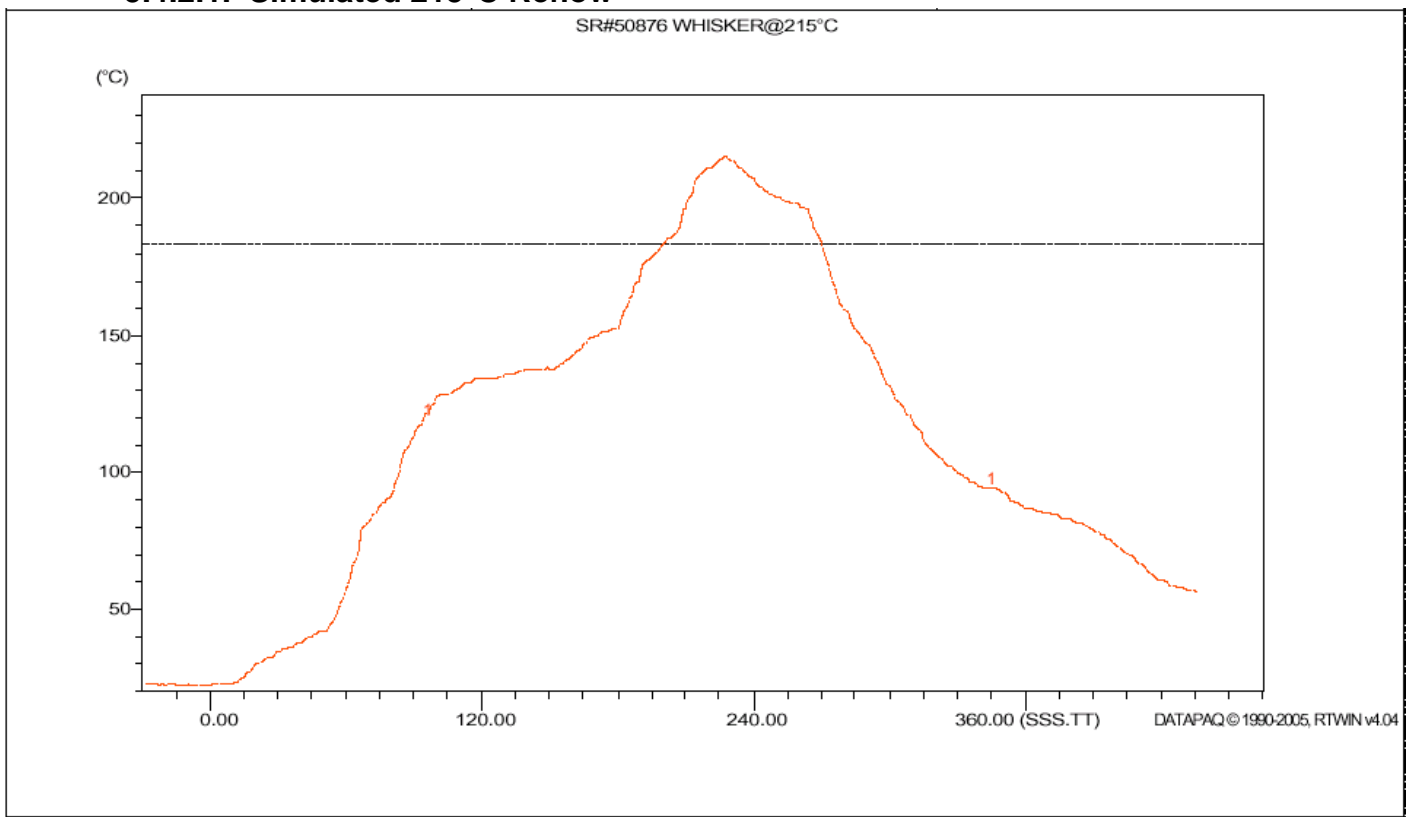
Instrument maker : Olympus
Model number : SZ40
Magnification : 40-60x

5.4.1.2. SEM

Instrument maker : Hitachi
Model number : S4500 & S3000N
Magnification : 500kx

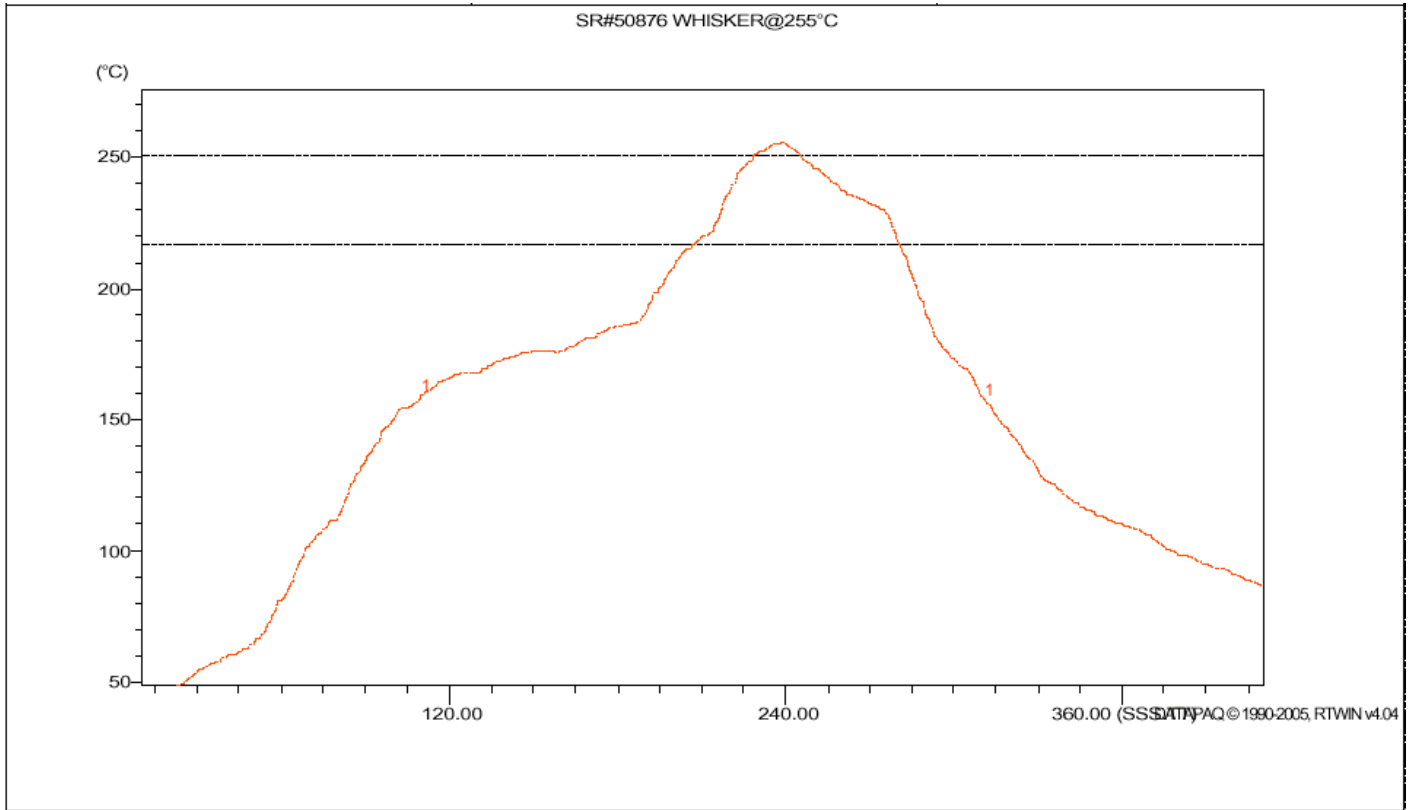
5.4.2. Reflow Profiles

5.4.2.1. Simulated 215°C Reflow



WHISKER TEST REPORT (FINAL REPORT)

5.4.2.2. Simulated 255°C Reflow



WHISKER TEST REPORT (FINAL REPORT)

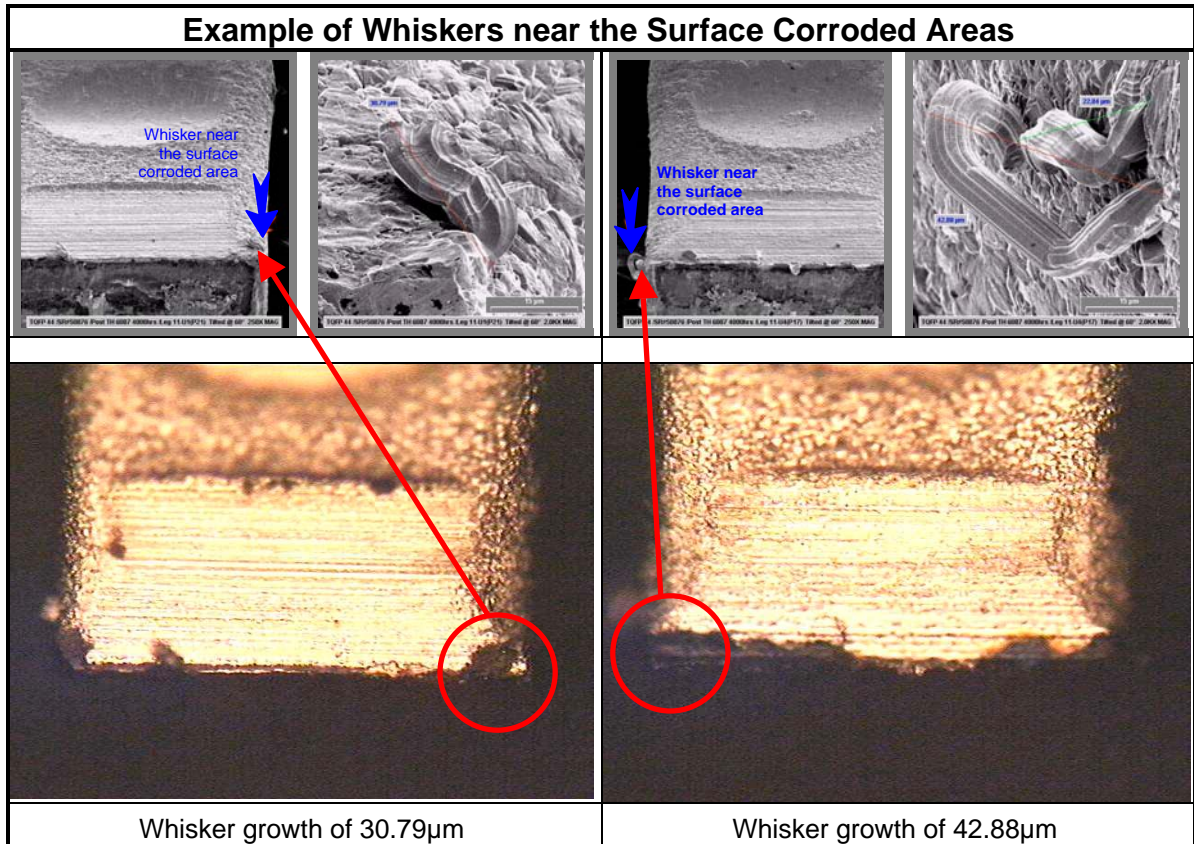
5.4.3. Verification Results of Terminations with Surface Corrosion

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

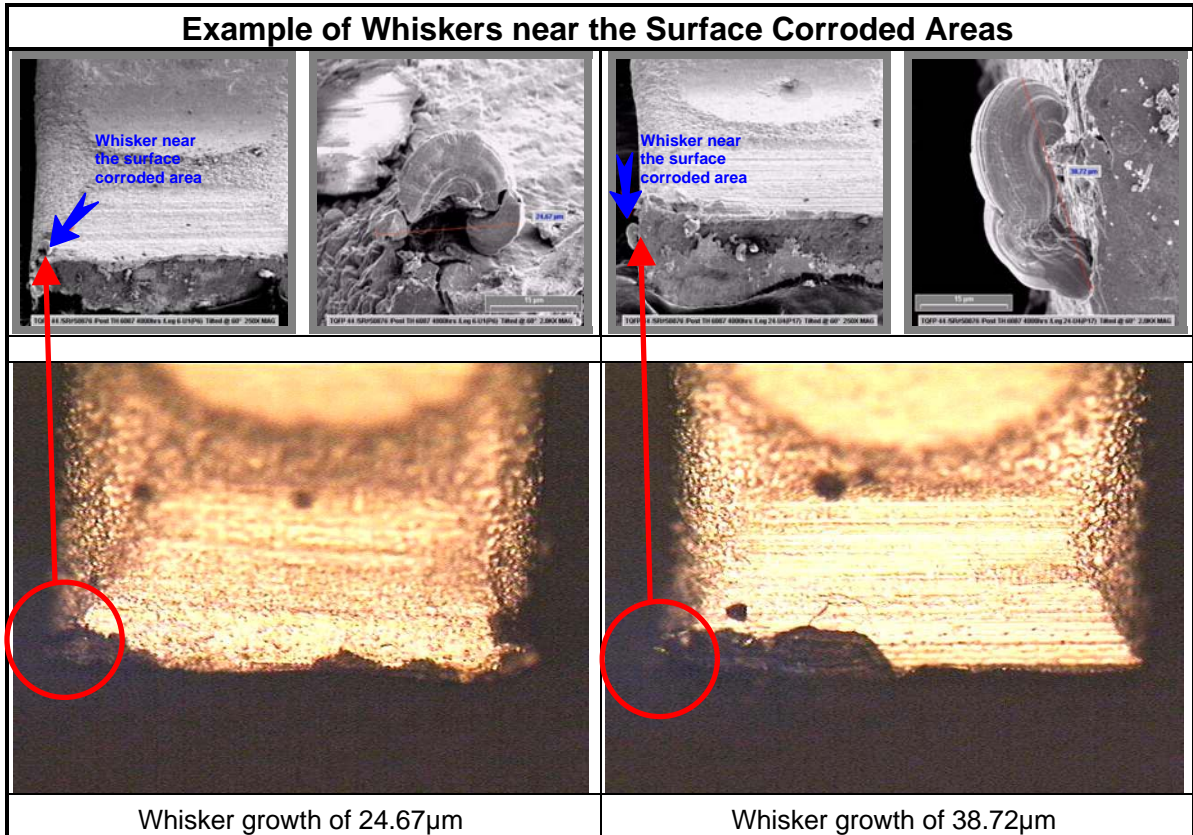
5.4.3.2.1. High Temperature/Humidity (60°C/87%RH)



WHISKER TEST REPORT (FINAL REPORT)

5.4.3.2.2. High Temperature/Humidity (60°C/87%RH) post 215°C simulated reflow

Example of Whiskers near the Surface Corroded Areas



WHISKER TEST REPORT (FINAL REPORT)

5.4.3.2.3. High Temperature/Humidity (60°C/87%RH) post 255°C simulated reflow

Example of Whiskers near the Surface Corroded Areas

