
WHISKER TEST REPORT (FINAL REPORT)

General Information

Factory	Amkor Technology Korea – ATK1
Plating Finish	Matte Sn
Package Type	MLF
Plating Chemistry	ST380
Plating Line	K1T4
Post Plating Bake	150°C for 1 hour

Report Date : January 11, 2007
Whisker Test Report # : 20060577

Prepared by : Sonny M. Copon
Reliability Engineer

Checked by : Roque Baliwan
Section Manager, Rel/FA

Approved by : Bernard Baylon
Department Manager, Rel/FA

Distribution List :

JungGon Choi, BongSeo Park – ATK1 Bryan Rigg, Henry Carteciano, Greg Gabriel, Sandra Gonzales, Eduardo Mertola, Leonida Dapula, Rodrigo Amor, Avelette Tan – ATP KwangBok Yang, GiSong Lee – WW Corp. PIC Don Foster – ATI
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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.

WHISKER TEST REPORT (FINAL REPORT)

1. Purpose

1.1. Whisker Test on MLF 32lds (C194 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 1000cyc, & 1500cyc exposure at -55°C/+85°C TC conditions showed whisker growth in all 3 lots. Longest whiskers observed post 1500cyc were:
 – TC without precon: comp#2, term#26 with 21.50µm;
 – TC with 215°C simulated reflow: comp#2, term#31 with 20.60µm; and
 – TC with 255°C simulated reflow: comp#4, term#31 with 18.57µm.

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

3.2.4. Post 1000hrs, 2000hrs, & 3000hrs exposure at 55°C/85%RH TH conditions did not manifest any whisker in all samples. At post 4000hrs, whisker was observed in sample that undergoes TH without precon. Longest whisker observed was 8.81µm in comp#1 term#17.

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4. Package / Material Description

4.1. Package

Type	MLF
Body size	5mm nominal
Lead Count	32L
Lead Pitch	0.50mm
Lead to Lead Gap	0.27mm nominal

4.2. Material

Lead frame	
Base metal alloy	C194
Temper (1/2 hard, etc.)	N/A
Stamped/Etched L/F	Etched
L/F thickness	0.20mm nominal
Barrier layer type	N/A
Barrier layer thickness	N/A

4.3. Process Dates

	Lot #1	Lot #2	Lot #3
Plating date/time	04/27/06 / 1330H	05/04/06 / 1311H	05/11/06 / 1456H
Post bake date/time	04/27/06 / 1410H	05/04/06 / 1345H	05/11/06 / 1531H
Simulated reflow date	05/26/06	05/26/06	05/26/06
Board assembly date	N/A	N/A	N/A
30°C/60%RH start date	05/26/06	05/26/06	05/26/06
55°C/85%RH start date	05/26/06	05/26/06	05/26/06
-55°C/85°C start date	05/26/06	05/26/06	05/26/06

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	K1T4/Technic	Belt Speed Descal <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 – Additive (Primary) • Concentration – Additive (Secondary) • Concentration – Additive (Anti Oxidant) • Bath Temperature Impurities <ul style="list-style-type: none"> • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn⁺⁴ 	70.10 mm/sec 23°C 31.34 g/l 17.47 ml/l 150 ASF 202/160/231/244 353.95 ml/l 71.12 g/l N/A N/A 81.64 ml/l 5.09 ml/l 18.95 ml/l 27.30°C 246.70 ppm 3.78 ppm 0.36 ppm 12.12 ppm 1.33 ppm 10.14 ppm	Descal Solution	Excel 90
Post Plating Bake	11-A/Hanseo	Hold Temperature Dwell Time Total Cycle Time	150°C 60 minutes 70 minutes		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature Dwell Time > 183°C	219°C 71 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	259°C 71 seconds		

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Lot# : LOT-2

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	K1T4/Technic	Belt Speed Descale <ul style="list-style-type: none"> • Temperature 23.10°C • Concentration – Salt 28.56 g/l • Concentration – Acid 20.15 ml/l Plating <ul style="list-style-type: none"> • Current Density 150 ASF • Ampere / cell 198/158/233/240 • Concentration – Acid 341.11 ml/l • Concentration – Tin 75.52 g/l • Concentration – Pb N/A • Concentration – Bi N/A • Concentration – Additive (Primary) 80.22 ml/l • Concentration – Additive (Secondary) 4.58 ml/l • Concentration – Additive (Anti Oxidant) 18.84 ml/l • Bath Temperature 27.40°C Impurities <ul style="list-style-type: none"> • Carbon 202.30 ppm • Pb in deposit (for Matte Sn, Sn/Bi) 12.50 ppm • Cu 0.54 ppm • Fe 13.25 ppm • Ni 1.69 ppm • Sn⁺⁴ 11.22 ppm 	70.20 mm/sec	Descale Solution	Excel 90
Post Plating Bake	11-A/Hanseco	Hold Temperature 150°C Dwell Time 60 minutes Total Cycle Time 70 minutes			
Simulated Reflow @ 215°C	Vitronics	Peak Temperature 219°C Dwell Time > 183°C 71 seconds			
Simulated Reflow @ 255°C	Vitronics	Peak Temperature 259°C Dwell Time > 217°C 71 seconds			

WHISKER TEST REPORT (FINAL REPORT)

Lot# : LOT-3

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	K1T4/Technic	Belt Speed Descale • Temperature • Concentration – Salt • Concentration – Acid Plating • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Additive (Primary) • Concentration – Additive (Secondary) • Concentration – Additive (Anti Oxidant) • Bath Temperature Impurities • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn ⁺⁴	69.80 mm/sec 22.90°C 24.12 g/l 20.19 ml/l 150 ASF 205/161/230/245 338.22 ml/l 74.24 g/l N/A N/A 72.25 ml/l 3.54 ml/l 17.84 ml/l 26.90°C 195.10 ppm 10.21 ppm 0.64 ppm 10.75 ppm 1.22 ppm 15.84 ppm	Descale Solution	Excel 90
Post Plating Bake	11-A/Hanseco	Hold Temperature Dwell Time Total Cycle Time	150°C 60 minutes 70 minutes		
Simulated Reflow @ 215°C	Vitronics	Peak Temperature Dwell Time > 183°C	219°C 71 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	259°C 71 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	0/5strips	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	300 – 600µ” (7.62 – 15.24µm)	0/10points	443.20	385.60	423.21	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	4.22	2.45	3.24	

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	0/5strips	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	300 – 600µ” (7.62 – 15.24µm)	0/10points	455.00	391.20	422.71	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	2.45	2.19	2.31	

Lot# : LOT-3

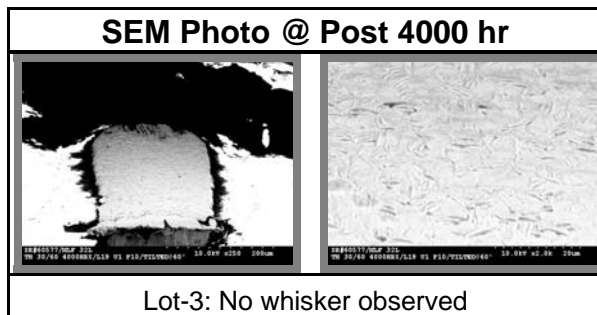
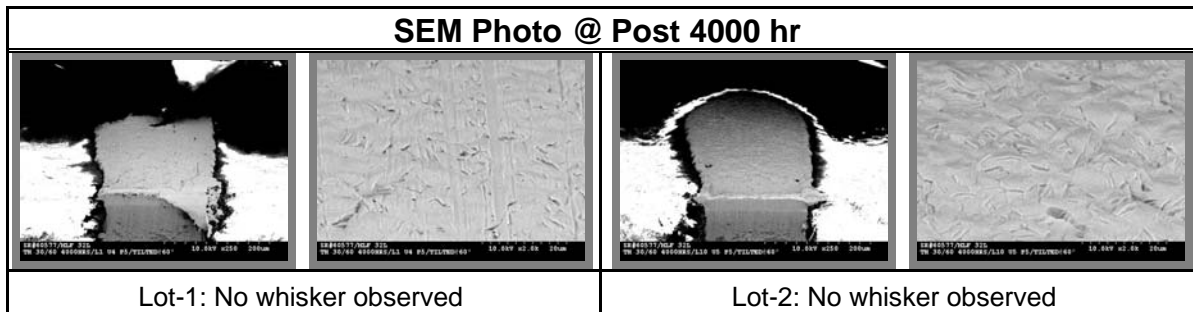
Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/5strips	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	300 – 600µ” (7.62 – 15.24µm)	0/10points	472.20	412.00	441.85	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	3.63	2.45	2.88	

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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>4</u> / Term # <u>5</u>	none	none	none	none	none
Lot-2	Comp # <u>5</u> / Term # <u>5</u>	none	none	none	none	none
Lot-3	Comp # <u>1</u> / Term # <u>10</u>	none	none	none	none	none

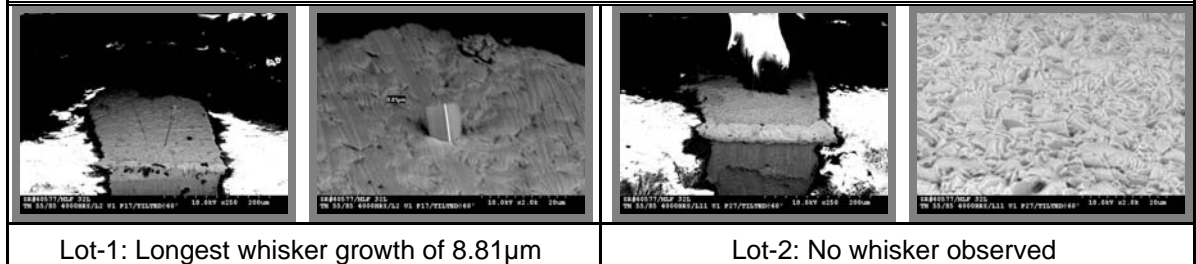


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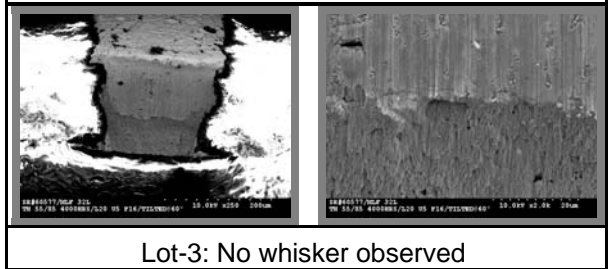
5.3.2. High Temperature/Humidity (55°C/85%RH)

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>17</u>	none	none	none	none	8.81µm
Lot-2	Comp # <u>1</u> / Term # <u>27</u>	none	none	none	none	none
Lot-3	Comp # <u>5</u> / Term # <u>16</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr



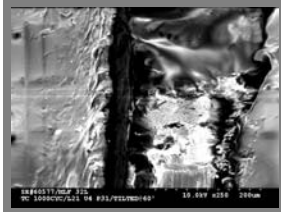
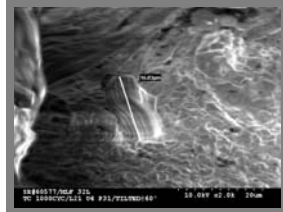

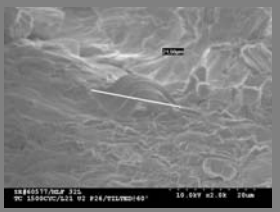
SEM Photo @ Post 4000 hr



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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>3</u> / Term # <u>27</u>	none	none	9.23µm	16.05µm
	Comp # <u>1</u> / Term # <u>10</u>	none	none	8.64µm	-
	Comp # <u>1</u> / Term # <u>13</u>	none	none	-	20.57µm
Lot-2	Comp # <u>4</u> / Term # <u>32</u>	none	none	13.72µm	15.79µm
	Comp # <u>6</u> / Term # <u>27</u>	none	none	-	19.68µm
Lot-3	Comp # <u>4</u> / Term # <u>31</u>	none	none	16.03µm	-
	Comp # <u>3</u> / Term # <u>20</u>	none	none	8.53µm	-
	Comp # <u>2</u> / Term # <u>26</u>	none	none	-	21.50µm
	Comp # <u>1</u> / Term # <u>26</u>	none	none	-	14.60µm

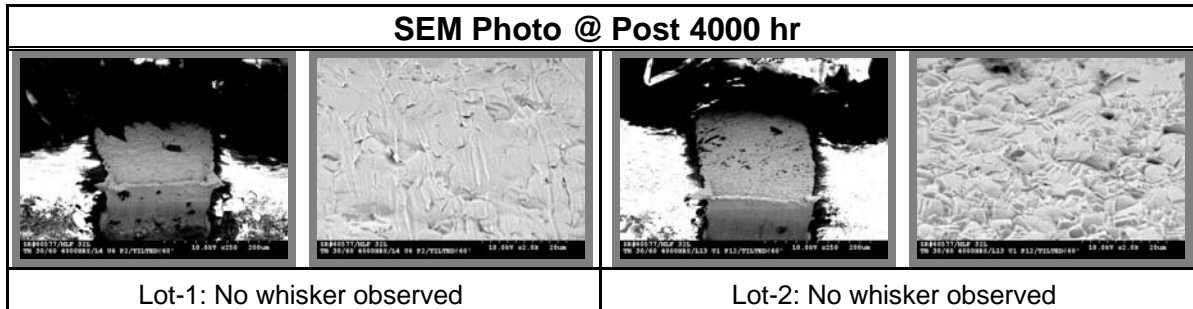
SEM Photo @ Post 1000 cyc		SEM Photo @ Post 1500 cyc	
			
Longest whisker growth of 16.03µm		Longest whisker growth of 21.50µm	

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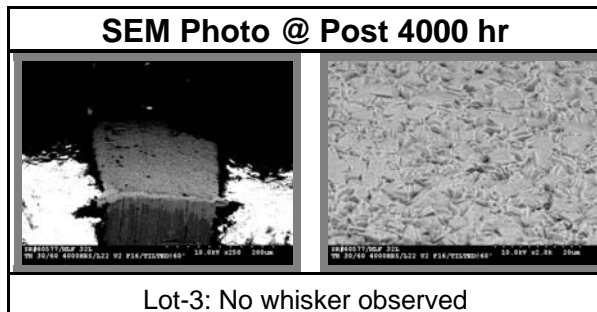
5.3.4. Ambient Temperature/Humidity (30°C/60%RH) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>6</u> / Term # <u>2</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>2</u> / Term # <u>16</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr



SEM Photo @ Post 4000 hr

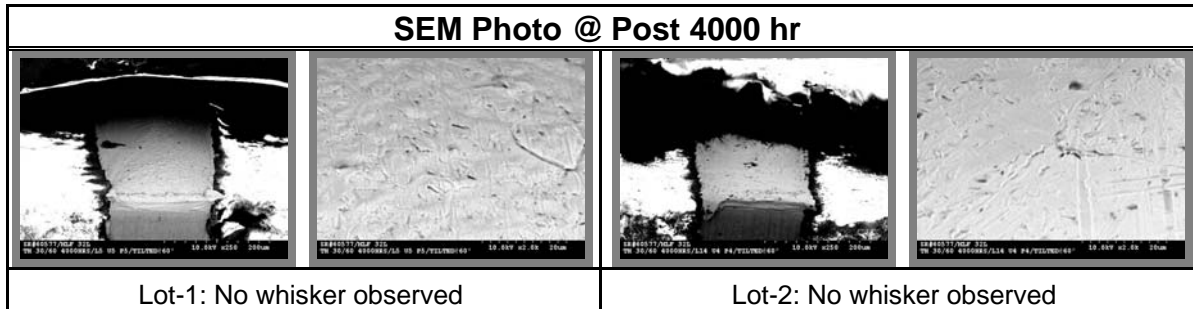


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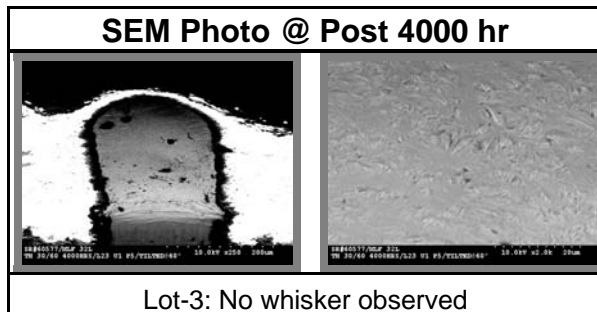
5.3.5. Ambient Temperature/Humidity (30°C/60%RH) post 255°C simulated reflow

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

SEM Photo @ Post 4000 hr



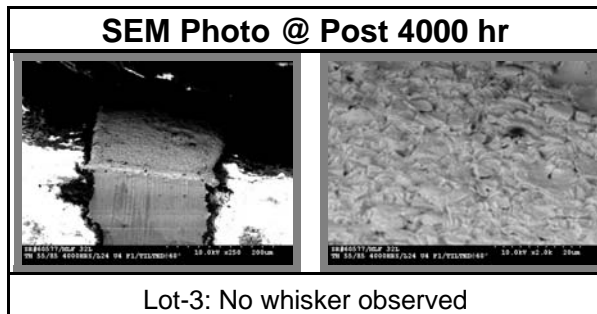
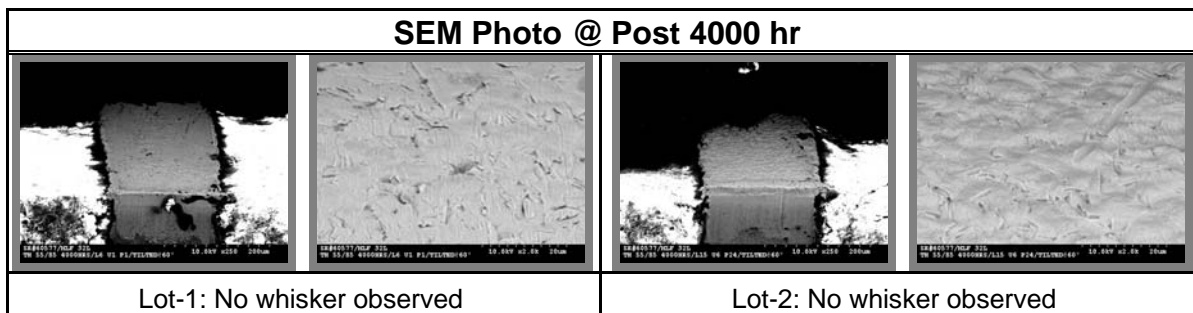
SEM Photo @ Post 4000 hr



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5.3.6. High Temperature/Humidity (55°C/85%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>1</u>	none	none	none	none	none
Lot-2	Comp # <u>6</u> / Term # <u>24</u>	none	none	none	none	none
Lot-3	Comp # <u>4</u> / Term # <u>1</u>	none	none	none	none	none

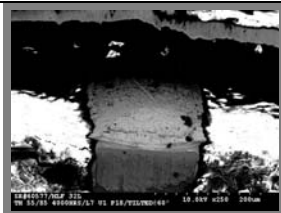
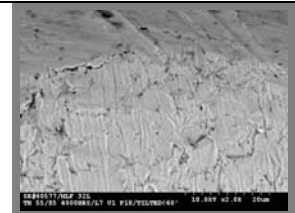
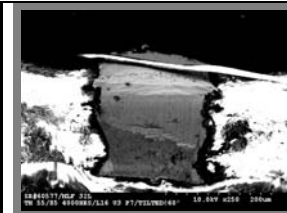
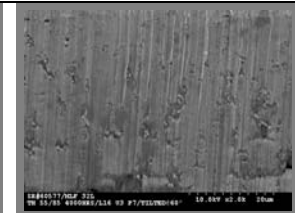


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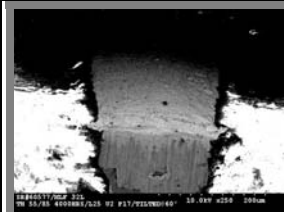
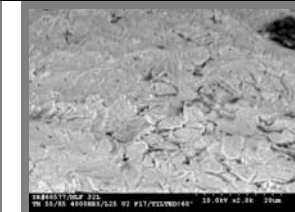
5.3.7. High Temperature/Humidity (55°C/85%RH) post 255°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>18</u>	none	none	none	none	none
Lot-2	Comp # <u>3</u> / Term # <u>7</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>17</u>	none	none	none	none	none

SEM Photo @ Post 4000 hr

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

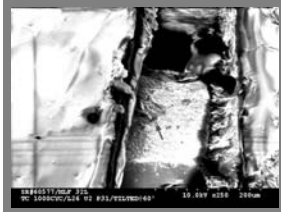
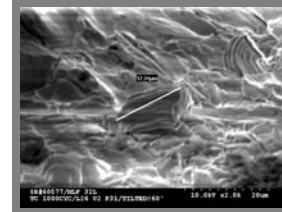

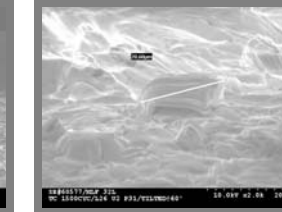
SEM Photo @ Post 4000 hr

	
Lot-3: No whisker observed	

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


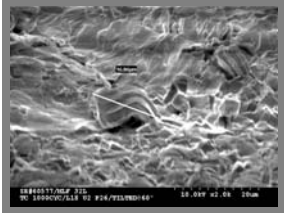

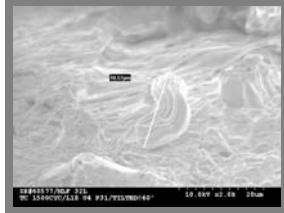
Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>3</u> / Term # <u>29</u>	none	none	8.98µm	12.91µm
	Comp # <u>3</u> / Term # <u>31</u>	none	none	8.73µm	-
	Comp # <u>2</u> / Term # <u>12</u>	none	none	-	8.62µm
Lot-2	Comp # <u>2</u> / Term # <u>12</u>	none	none	14.78µm	-
	Comp # <u>4</u> / Term # <u>13</u>	none	none	9.42µm	-
	Comp # <u>2</u> / Term # <u>11</u>	none	none	-	15.53µm
	Comp # <u>4</u> / Term # <u>14</u>	none	none	-	12.96µm
Lot-3	Comp # <u>2</u> / Term # <u>31</u>	none	none	17.31µm	20.60µm
	Comp # <u>4</u> / Term # <u>7</u>	none	none	8.48µm	12.56µm

SEM Photo @ Post 1000 cyc		SEM Photo @ Post 1500 cyc	
			
Longest whisker growth of 17.31µm		Longest whisker growth of 20.60µm	

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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>3</u> / Term # <u>12</u>	none	none	14.74µm	-
	Comp # <u>1</u> / Term # <u>7</u>	none	none	12.90µm	-
	Comp # <u>3</u> / Term # <u>14</u>	none	none	-	17.45µm
	Comp # <u>1</u> / Term # <u>4</u>	none	none	-	15.51µm
Lot-2	Comp # <u>1</u> / Term # <u>26</u>	none	none	11.87µm	-
	Comp # <u>2</u> / Term # <u>26</u>	none	none	16.86µm	-
	Comp # <u>3</u> / Term # <u>20</u>	none	none	-	14.04µm
	Comp # <u>4</u> / Term # <u>31</u>	none	none	-	18.57µm
Lot-3	Comp # <u>2</u> / Term # <u>11</u>	none	none	14.33µm	-
	Comp # <u>2</u> / Term # <u>4</u>	none	none	12.01µm	15.93µm
	Comp # <u>1</u> / Term # <u>5</u>	none	none	-	14.99µm

SEM Photo @ Post 1000 cyc		SEM Photo @ Post 1500 cyc	
			
Longest whisker growth of 16.86µm		Longest whisker growth of 18.57µm	

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5.4. Appendix

5.4.1. Inspection Equipment

5.4.1.1. Optical Microscope

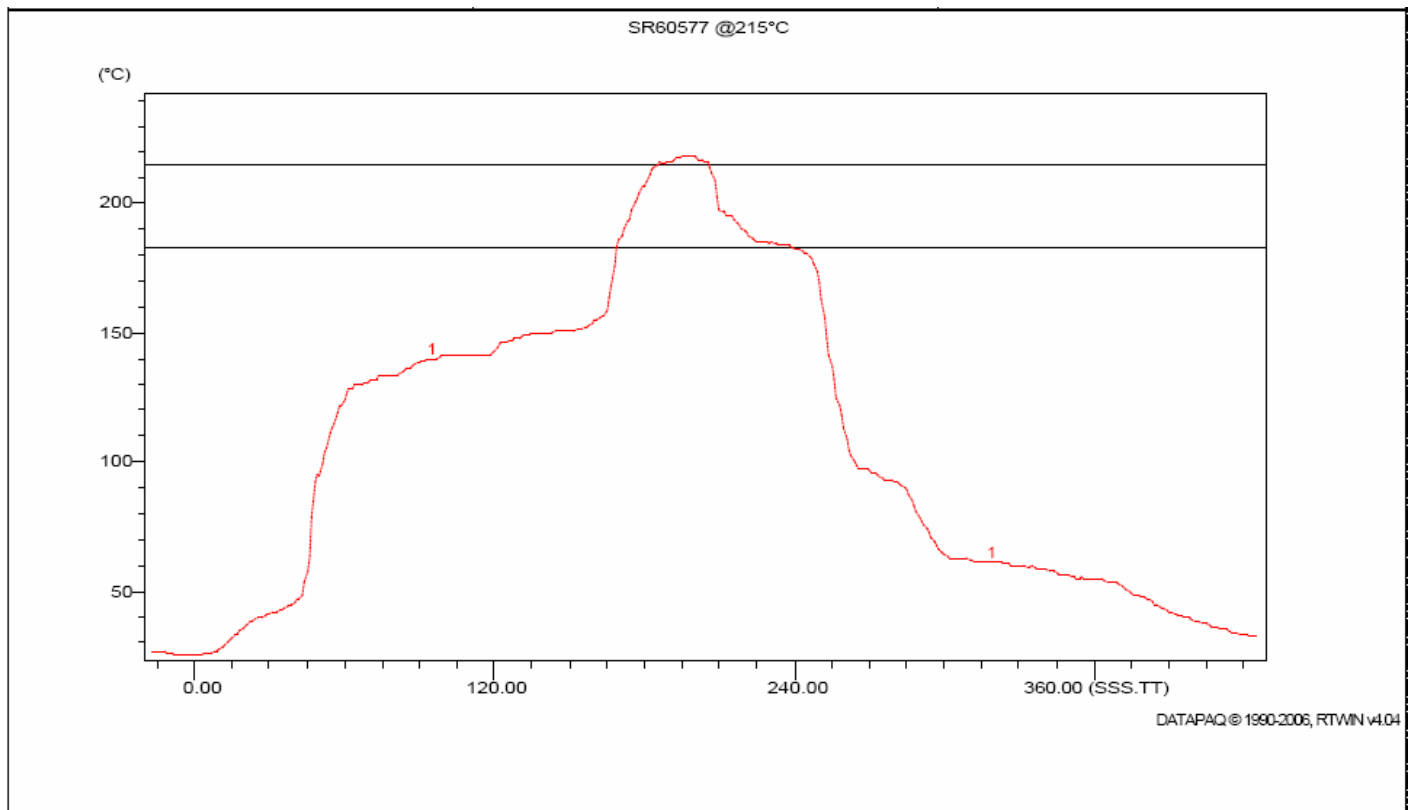
Instrument maker : Olympus
Model number : SZ40
Magnification : 40-60x

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

