
WHISKER TEST REPORT (FINAL REPORT)

General Information

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

Report Date : December 28, 2006
Whisker Test Report # : 20060571

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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 100lds (EFTEC-64T 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 post 1500cyc were:
 - TC without precon: comp#1, term#6 with 30.65µm;
 - TC with 215°C simulated reflow: comp#4, term#13 with 31.30µm; and
 - TC with 255°C simulated reflow: comp#6, term#1 with 33.09µm.
- 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 tested at TH with 215°C simulated reflow. Longest whisker observed was 10.00µm in comp#5 term#10.

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4. Package / Material Description

4.1. Package

Type	TQFP
Body size	14x14 mm
Lead Count	100L
Lead Pitch	0.50 mm
Lead to Lead Gap	0.275 mm

4.2. Material

Lead frame	
Base metal alloy	EFTEC-64T
Temper (1/2 hard, etc.)	N/A
Stamped/Etched L/F	Stamped
L/F thickness	0.13 mm
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 / 1030H	05/04/06 / 1011H	05/11/06 / 0956H
Post bake date/time	04/27/06 / 1110H	05/04/06 / 1045H	05/11/06 / 1031H
Simulated reflow date	05/27/06	05/27/06	05/27/06
Board assembly date	N/A	N/A	N/A
30°C/60%RH start date	05/27/06	05/27/06	05/27/06
55°C/85%RH start date	05/27/06	05/27/06	05/27/06
-55°C/85°C start date	05/27/06	05/27/06	05/27/06

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 23.10°C 31.44 g/l 17.47 ml/l 150 ASF 160/132/193/201 353.95 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/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	216°C 70 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	256°C 71 seconds		

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Lot# : LOT-2

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	K1T4/Technic	Belt Speed Descal • 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	70.20 mm/sec 23.10°C 28.56 g/l 20.15 ml/l 150 ASF 165/128/190/211 341.11 ml/l 75.52 g/l N/A N/A 80.22 ml/l 4.58 ml/l 18.84 ml/l 27.40°C 202.30 ppm 12.50 ppm 0.54 ppm 13.25 ppm 1.69 ppm 11.22 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	216°C 70 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	256°C 71 seconds		

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Lot# : LOT-3

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	K1T4/Technic	Belt Speed Descal <ul style="list-style-type: none"> • Temperature 22.90°C • Concentration – Salt 24.12 g/l • Concentration – Acid 20.19 ml/l Plating <ul style="list-style-type: none"> • Current Density 150 ASF • Ampere / cell 155/122/204/192 • Concentration – Acid 338.22 ml/l • Concentration – Tin 74.24 g/l • Concentration – Pb N/A • Concentration – Bi N/A • Concentration – Additive (Primary) 72.25 ml/l • Concentration – Additive (Secondary) 3.54 ml/l • Concentration – Additive (Anti Oxidant) 17.84 ml/l • Bath Temperature 26.90°C Impurities <ul style="list-style-type: none"> • Carbon 195.10 ppm • Pb in deposit (for Matte Sn, Sn/Bi) 10.21 ppm • Cu 0.64 ppm • Fe 10.75 ppm • Ni 1.22 ppm • Sn⁺⁴ 15.84 ppm 	69.80 mm/sec	Descal Solution	Excel 90
Post Plating Bake	11-A/Hanseo	Hold Temperature 150°C Dwell Time 60 minutes Total Cycle Time 70 minutes			
Simulated Reflow @ 215°C	Vitronics	Peak Temperature 216°C Dwell Time > 183°C 70 seconds			
Simulated Reflow @ 255°C	Vitronics	Peak Temperature 256°C Dwell Time > 217°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	400 – 700 μ " (10 – 17.50 μ m)	0/10points	652.30	431.40	526.94	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	3.17	1.91	2.51	

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	400 – 700 μ " (10 – 17.50 μ m)	0/10points	592.30	452.40	526.77	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	2.86	2.04	2.58	

Lot# : LOT-3

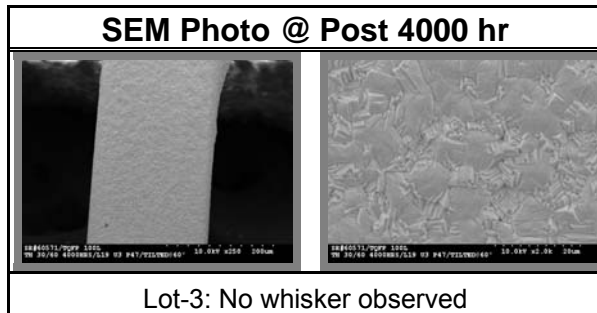
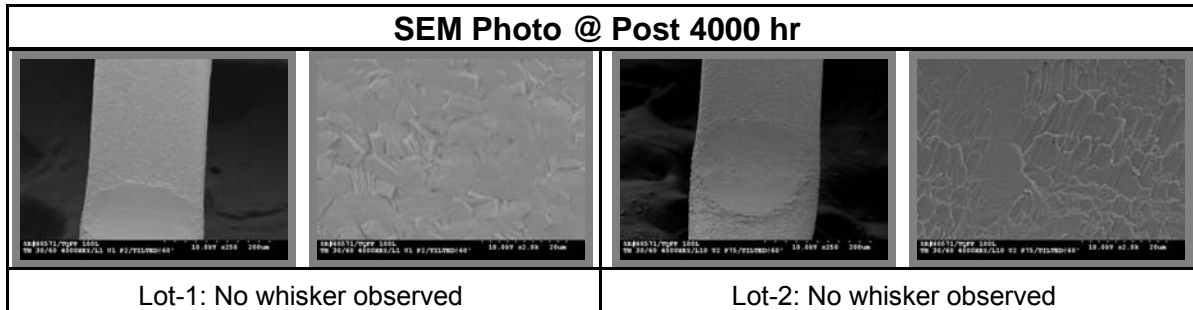
Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/5strips	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700 μ " (10 – 17.50 μ m)	0/10points	603.50	458.10	538.59	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	3.06	2.15	2.68	

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5.3. Whisker Test Summary

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

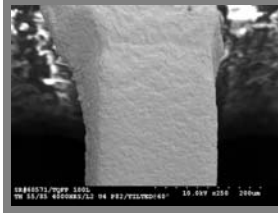
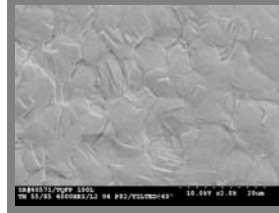
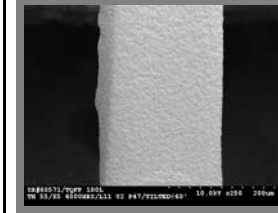
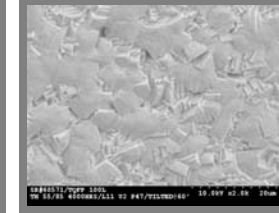
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>1</u> / Term # <u>2</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>75</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>47</u>	none	none	none	none	none

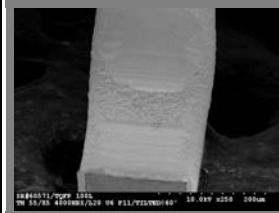
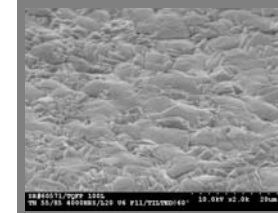


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5.3.2. High Temperature/Humidity (55°C/85%RH)

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>4</u> / Term # <u>82</u>	none	none	none	none	none
Lot-2	Comp # <u>2</u> / Term # <u>47</u>	none	none	none	none	none
Lot-3	Comp # <u>6</u> / Term # <u>11</u>	none	none	none	none	none


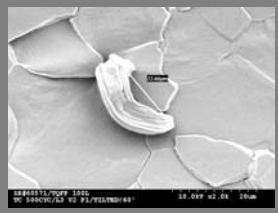
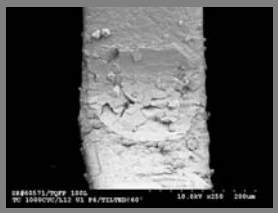

SEM Photo @ Post 4000 hr			
			
Lot-1: No whisker observed		Lot-2: No whisker observed	


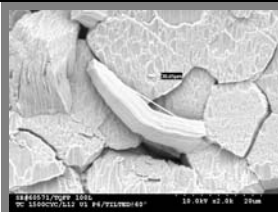
SEM Photo @ Post 4000 hr	
	
Lot-3: No whisker observed	

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5.3.3. Thermal Cycling (-55/85°C)

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>1</u> / Term # <u>61</u>	none	14.29µm	-	-
	Comp # <u>2</u> / Term # <u>1</u>	none	22.66µm	-	-
	Comp # <u>1</u> / Term # <u>71</u>	none	-	17.58µm	19.35µm
	Comp # <u>2</u> / Term # <u>35</u>	none	-	23.72µm	-
	Comp # <u>2</u> / Term # <u>36</u>	none	-	-	25.56µm
Lot-2	Comp # <u>1</u> / Term # <u>6</u>	none	12.75µm	27.24µm	30.65µm
	Comp # <u>4</u> / Term # <u>6</u>	none	20.98µm	21.73µm	-
	Comp # <u>4</u> / Term # <u>11</u>	none	-	-	25.13µm
Lot-3	Comp # <u>1</u> / Term # <u>22</u>	none	20.12µm	24.29µm	-
	Comp # <u>2</u> / Term # <u>14</u>	none	15.92µm	16.54µm	19.37µm
	Comp # <u>1</u> / Term # <u>23</u>	none	-	-	28.76µm

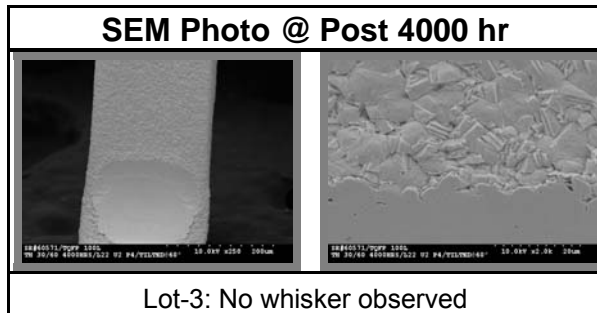
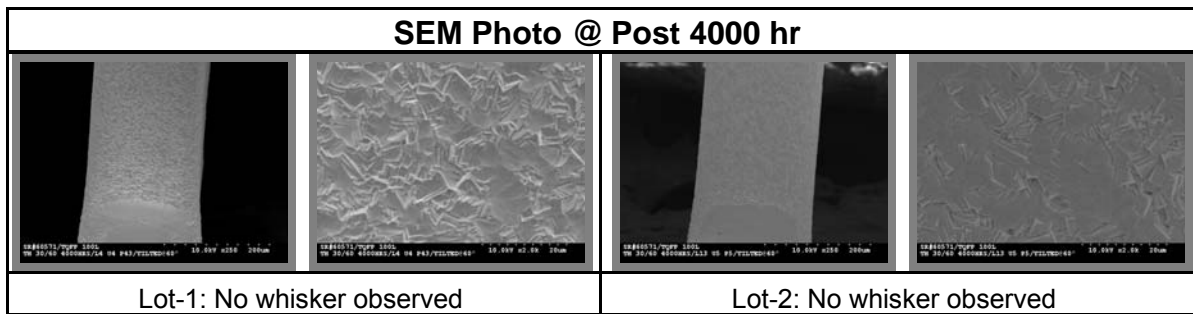
SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 22.66µm		Longest whisker growth of 27.24µm	

SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 30.65µm	

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

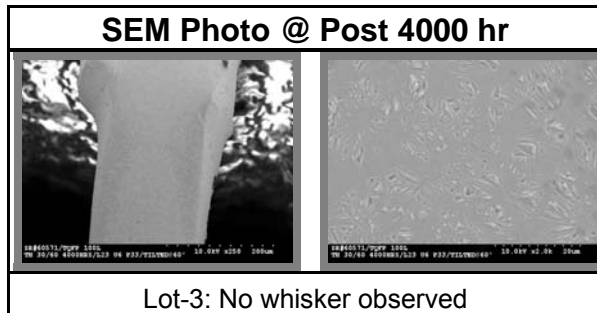
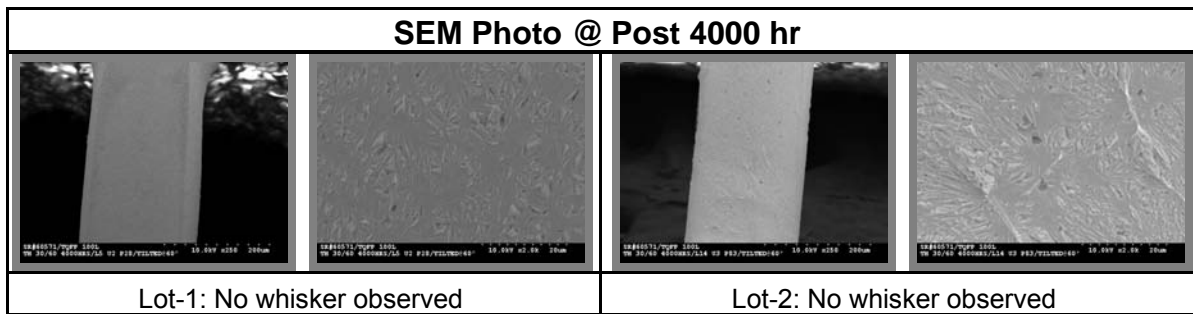
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>4</u> / Term # <u>43</u>	none	none	none	none	none
Lot-2	Comp # <u>5</u> / Term # <u>5</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>4</u>	none	none	none	none	none



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

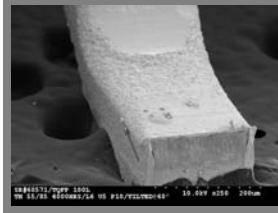

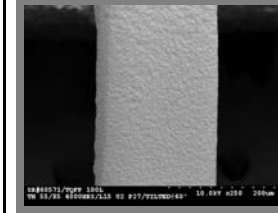
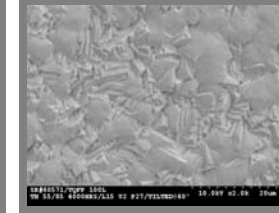
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>2</u> / Term # <u>28</u>	none	none	none	none	none
Lot-2	Comp # <u>3</u> / Term # <u>83</u>	none	none	none	none	none
Lot-3	Comp # <u>6</u> / Term # <u>33</u>	none	none	none	none	none


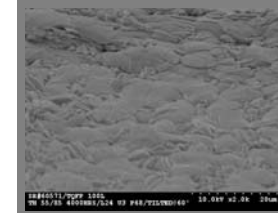


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5.3.6. High Temperature/Humidity (55°C/85%RH) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>5</u> / Term # <u>10</u>	none	none	none	none	10.00µm
Lot-2	Comp # <u>2</u> / Term # <u>27</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>68</u>	none	none	none	none	none

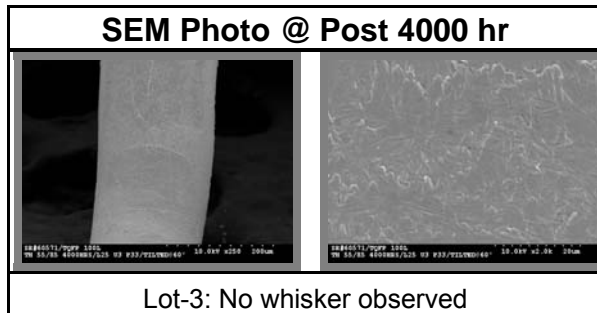
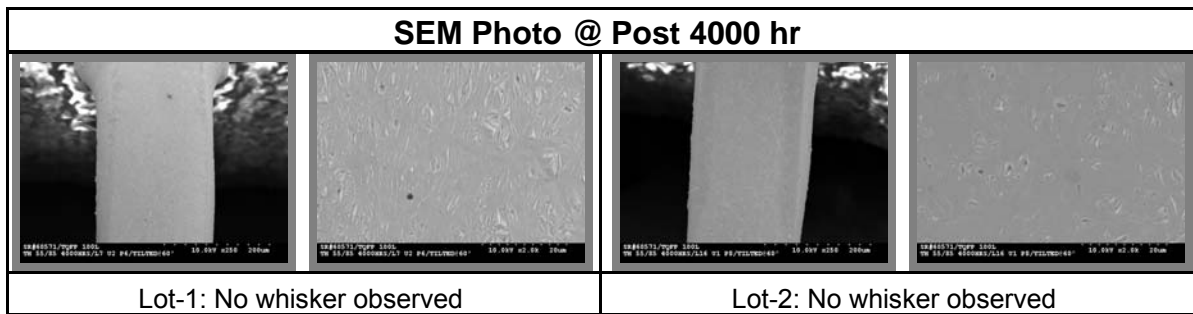
SEM Photo @ Post 4000 hr			
			
Lot-1: Longest whisker growth of 10.00µm		Lot-2: No whisker observed	

SEM Photo @ Post 4000 hr	
	
Lot-3: No whisker observed	

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


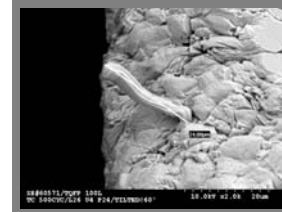

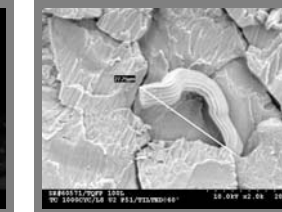
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3000 hr	4000 hr
Lot-1	Comp # <u>2</u> / Term # <u>6</u>	none	none	none	none	none
Lot-2	Comp # <u>1</u> / Term # <u>8</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>33</u>	none	none	none	none	none

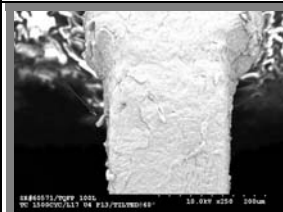



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5.3.8. Thermal Cycling (-55/85°C) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>2</u> / Term # <u>51</u>	none	21.31µm	27.75µm	28.44µm
	Comp # <u>5</u> / Term # <u>23</u>	none	19.95µm	20.56µm	20.99µm
Lot-2	Comp # <u>4</u> / Term # <u>18</u>	none	18.79µm	-	-
	Comp # <u>5</u> / Term # <u>23</u>	none	14.46µm	19.73µm	22.12µm
	Comp # <u>4</u> / Term # <u>17</u>	none	-	25.18µm	-
	Comp # <u>4</u> / Term # <u>13</u>	none	-	-	31.30µm
Lot-3	Comp # <u>3</u> / Term # <u>1</u>	none	19.84µm	-	-
	Comp # <u>4</u> / Term # <u>24</u>	none	24.00µm	25.19µm	25.45µm
	Comp # <u>3</u> / Term # <u>17</u>	none	-	26.10µm	26.53µm

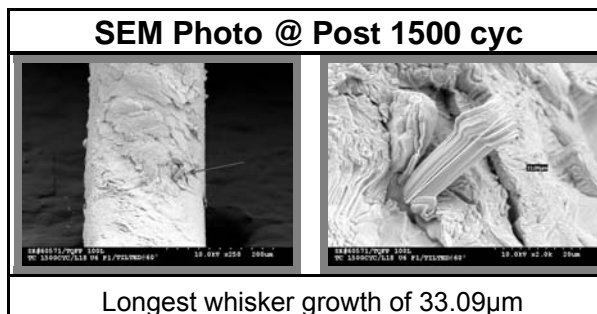
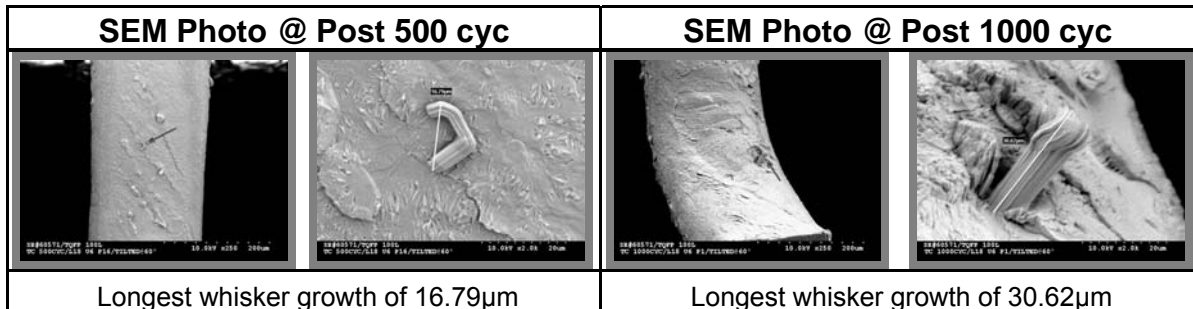
SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 24.00µm		Longest whisker growth of 27.75µm	

SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 31.30µm	

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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>6</u>	none	13.27µm	-	-
	Comp # <u>4</u> / Term # <u>64</u>	none	14.51µm	19.08µm	23.32µm
	Comp # <u>1</u> / Term # <u>24</u>	none	-	20.24µm	21.25µm
Lot-2	Comp # <u>3</u> / Term # <u>23</u>	none	15.23µm	17.45µm	18.15µm
	Comp # <u>6</u> / Term # <u>16</u>	none	16.79µm	-	-
	Comp # <u>6</u> / Term # <u>1</u>	none	-	30.62µm	33.09µm
Lot-3	Comp # <u>5</u> / Term # <u>1</u>	none	10.32µm	10.57µm	-
	Comp # <u>6</u> / Term # <u>21</u>	none	15.48µm	15.71µm	-
	Comp # <u>5</u> / Term # <u>4</u>	none	-	-	23.61µm
	Comp # <u>6</u> / Term # <u>7</u>	none	-	-	31.80µm



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5.4. Appendix

5.4.1. Inspection Equipment

5.4.1.1. Optical Microscope

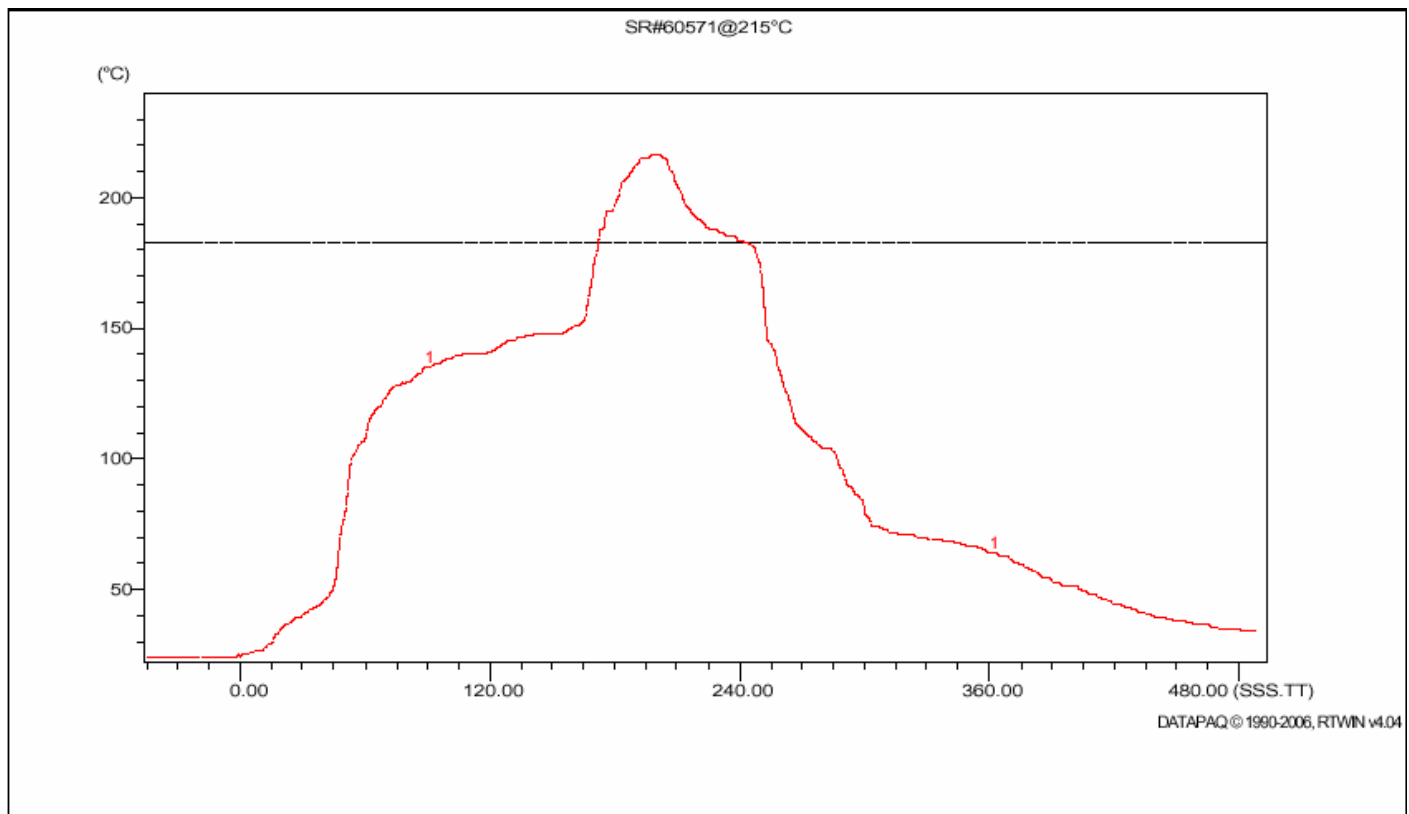
Instrument maker : Olympus
Model number : SZ40
Magnification : 40-60x

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



WHISKER TEST REPORT (FINAL REPORT)

5.4.2.2. Simulated 255°C Reflow

