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## WHISKER TEST REPORT (FINAL REPORT)

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### General Information

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

Report Date : January 15, 2007  
Whisker Test Report # : 20060623

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# WHISKER TEST REPORT

## (FINAL REPORT)

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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 SOIC 8lds (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 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#5 with 31.18µm;  
 – TC with 215°C simulated reflow: comp#5, term#3 with 38.40µm; and  
 – TC with 255°C simulated reflow: comp#6, term#3 with 27.08µm.

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. Two (2) 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	SOIC
Body size	391x155 mils
Lead Count	8L
Lead Pitch	50 mils
Lead to Lead Gap	N/A

#### 4.2. Material

Lead frame	
Base metal alloy	C194
Temper (1/2 hard, etc.)	Full Hard
Stamped/Etched L/F	Etched
L/F thickness	8 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 / 1115H	05/17/06 / 1425H	05/24/06 / 1630H
Post bake date/time	05/10/06 / 1135H	05/17/06 / 1440H	05/24/06 / 1655H
Simulated reflow date	06/14/06	06/14/06	06/14/06
Board assembly date	N/A	N/A	N/A
30°C/60%RH start date	06/14/06	06/14/06	06/14/06
55°C/85%RH start date	06/14/06	06/14/06	06/14/06
-55°C/85°C start date	06/14/06	06/14/06	06/14/06

### 5. Attachments

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

## WHISKER TEST REPORT (FINAL REPORT)

### 5.1. Process Summary

Lot# : LOT-1

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	<b>Belt Speed</b> <b>Descale</b> <ul style="list-style-type: none"> <li>• Temperature</li> <li>• Concentration – Salt</li> <li>• Concentration – Acid</li> </ul> <b>Plating</b> <ul style="list-style-type: none"> <li>• Current Density</li> <li>• Ampere / cell</li> <li>• Concentration – Acid</li> <li>• Concentration – Tin</li> <li>• Concentration – Pb</li> <li>• Concentration – Bi</li> <li>• Concentration – Additive (Primary)</li> <li>• Concentration – Additive (Secondary)</li> <li>• Bath Temperature</li> </ul> <b>Impurities</b> <ul style="list-style-type: none"> <li>• Carbon</li> <li>• Pb in deposit (for Matte Sn, Sn/Bi)</li> <li>• Cu</li> <li>• Fe</li> <li>• Ni</li> <li>• Sn<sup>+4</sup></li> </ul>	8 m/min  35°C 74.70 g/li NA  168.70 ASF 220 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	219°C 63 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	259°C 74 seconds		

## WHISKER TEST REPORT (FINAL REPORT)

Lot# : LOT-2

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	<b>Belt Speed</b> <b>Descal</b> • Temperature • Concentration – Salt • Concentration – Acid <b>Plating</b> • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Additive (Primary) • Concentration – Additive (Secondary) • Bath Temperature <b>Impurities</b> • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn <sup>+4</sup>	8 m/min  35°C 77.50 g/li NA  168.70 ASF 220 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%	Descal 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	219°C 63 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	259°C 74 seconds		

## WHISKER TEST REPORT (FINAL REPORT)

Lot# : LOT-3

PROCESS	MACHINE/ EQUIPMENT	PARAMETERS		MATERIALS	
Plating	Meco 6	<b>Belt Speed</b> <b>Descale</b> • Temperature • Concentration – Salt • Concentration – Acid <b>Plating</b> • Current Density • Ampere / cell • Concentration – Acid • Concentration – Tin • Concentration – Pb • Concentration – Bi • Concentration – Additive (Primary) • Concentration – Additive (Secondary) • Bath Temperature <b>Impurities</b> • Carbon • Pb in deposit (for Matte Sn, Sn/Bi) • Cu • Fe • Ni • Sn <sup>+4</sup>	8 m/min  35°C 80.70 g/li NA  168.70 ASF 220 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%	Descal 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	219°C 63 seconds		
Simulated Reflow @ 255°C	Vitronics	Peak Temperature Dwell Time > 217°C	259°C 74 seconds		

## WHISKER TEST REPORT (FINAL REPORT)

### 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	578.60	512.40	549.10	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	2.41	

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	575.80	515.80	548.50	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	1.95	1.80	1.89	

Lot# : LOT-3

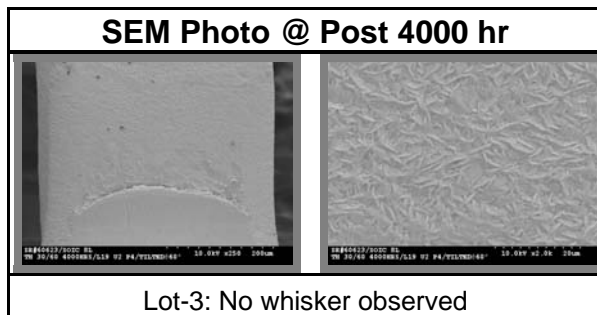
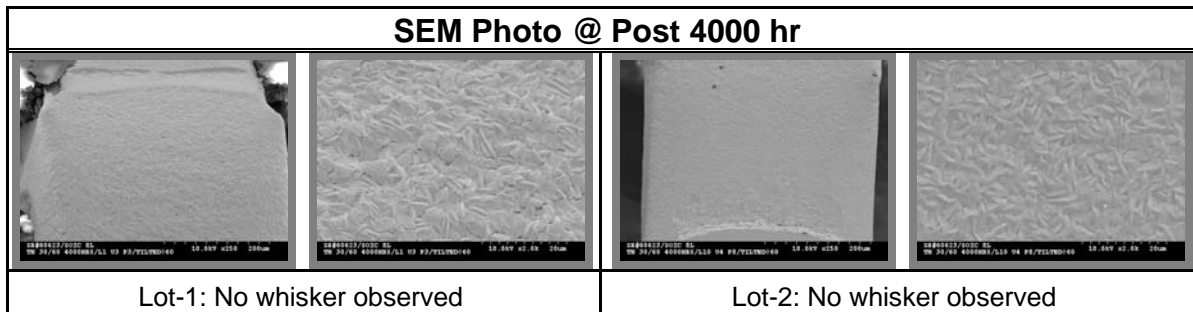
Process / SPEC No.	Test Item	SPEC # or Criteria	# Failure / S. Size	Test Data			Result
				MAX	MIN	AVG	
001-0530-2011	Visual	001-0322-2595	0/116	N/A	N/A	N/A	PASSED
001-0522-2571	Plating thickness	400 – 700µ” (10 – 17.50µm)	0/5 rdgs	572.40	508.70	549.10	PASSED
001-0522-2571	Deposit composition	100% Sn	N/A	N/A	N/A	N/A	100% Sn
Surface of Deposit	Grain size range	N/A	N/A	1.92	1.72	1.82	

# WHISKER TEST REPORT (FINAL REPORT)

## 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	3101 hr	4000 hr
Lot-1	Comp # <u>3</u> / Term # <u>3</u>	none	none	none	none	none
Lot-2	Comp # <u>4</u> / Term # <u>8</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>4</u>	none	none	none	none	none

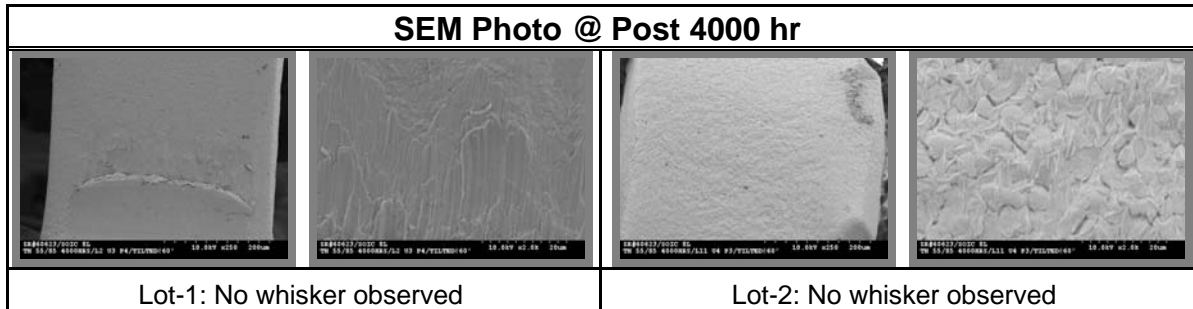


# WHISKER TEST REPORT (FINAL REPORT)

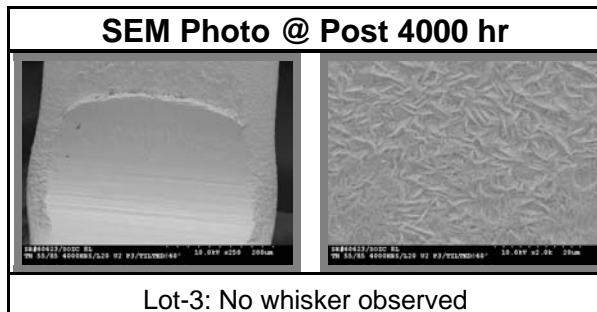
### 5.3.2. High Temperature/Humidity (55°C/85%RH)

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3161 hr	4000 hr
Lot-1	Comp # <u>3</u> / Term # <u>4</u>	none	none	none	none	none
Lot-2	Comp # <u>4</u> / Term # <u>3</u>	none	none	none	none	none
Lot-3	Comp # <u>2</u> / Term # <u>3</u>	none	none	none	none	none

#### SEM Photo @ Post 4000 hr




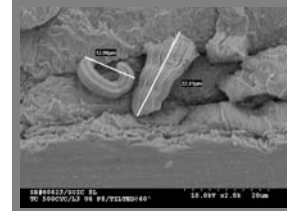
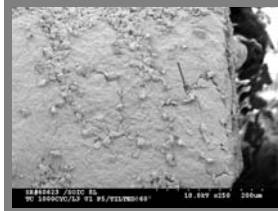

#### SEM Photo @ Post 4000 hr

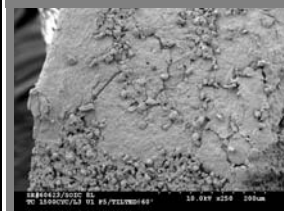



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### 5.3.3. Thermal Cycling (-55/85°C)

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>1</u> / Term # <u>5</u>	none	16.79µm	23.20µm	31.18µm
	Comp # <u>6</u> / Term # <u>8</u>	none	22.41µm	22.46µm	-
	Comp # <u>6</u> / Term # <u>7</u>	none	-	-	26.12µm
Lot-2	Comp # <u>1</u> / Term # <u>3</u>	none	17.16µm	21.23µm	23.29µm
	Comp # <u>2</u> / Term # <u>7</u>	none	14.30µm	17.65µm	20.20µm
Lot-3	Comp # <u>5</u> / Term # <u>4</u>	none	17.15µm	20.98µm	24.14µm
	Comp # <u>6</u> / Term # <u>5</u>	none	15.05µm	22.60µm	-
	Comp # <u>4</u> / Term # <u>1</u>	none	-	-	28.53µm

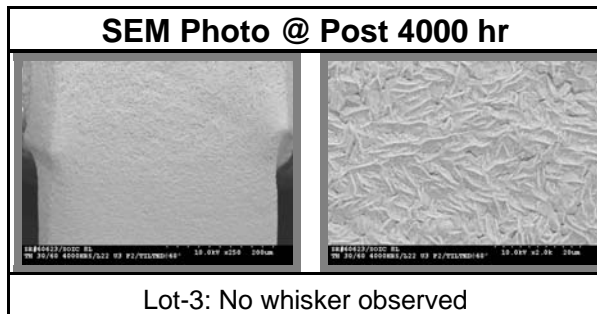
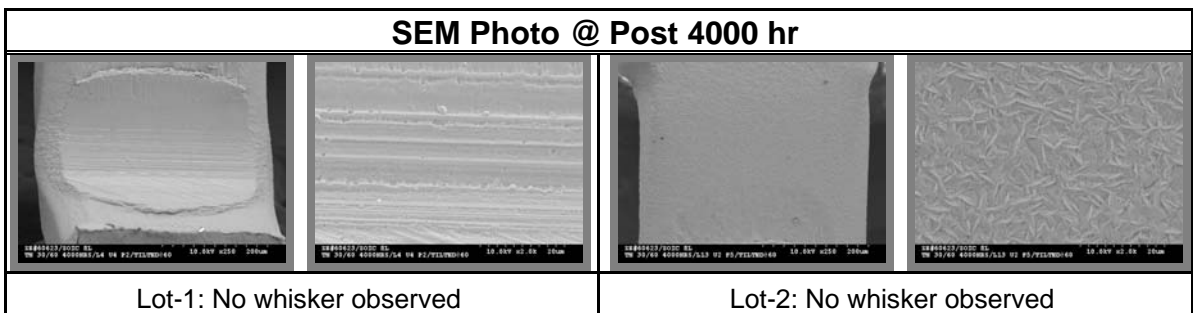
SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 22.41µm		Longest whisker growth of 23.20µm	

SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 31.18µm	

## WHISKER TEST REPORT (FINAL REPORT)

### 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	3101 hr	4000 hr
Lot-1	Comp # <u>4</u> / Term # <u>2</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>3</u> / Term # <u>2</u>	none	none	none	none	none

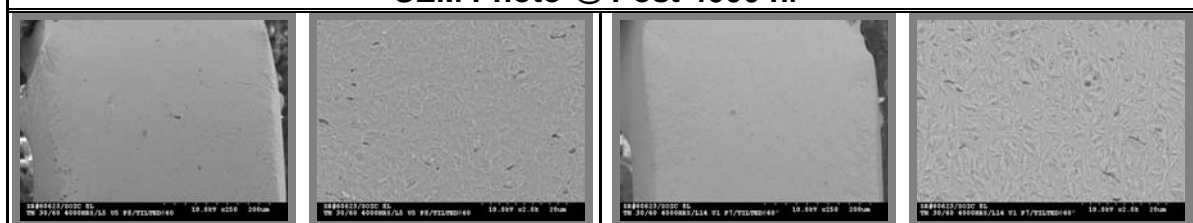


## WHISKER TEST REPORT (FINAL REPORT)

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

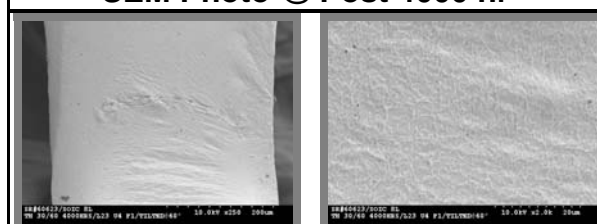
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3101 hr	4000 hr
Lot-1	Comp # <u>5</u> / Term # <u>8</u>	none	none	none	none	none
Lot-2	Comp # <u>1</u> / Term # <u>7</u>	none	none	none	none	none
Lot-3	Comp # <u>4</u> / Term # <u>1</u>	none	none	none	none	none

**SEM Photo @ Post 4000 hr**



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



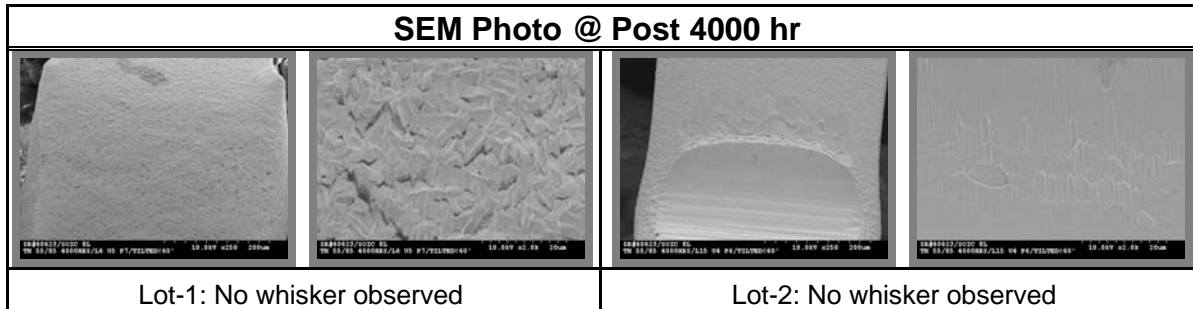
Lot-3: No whisker observed

## WHISKER TEST REPORT (FINAL REPORT)

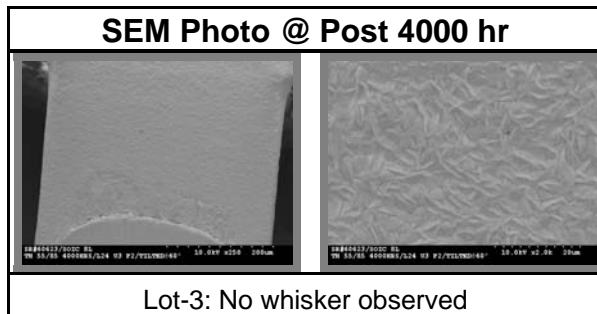
### 5.3.6. High Temperature/Humidity (55°C/85%RH) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3161 hr	4000 hr
Lot-1	Comp # <u>5</u> / Term # <u>7</u>	none	none	none	none	none
Lot-2	Comp # <u>4</u> / Term # <u>6</u>	none	none	none	none	none
Lot-3	Comp # <u>3</u> / Term # <u>2</u>	none	none	none	none	none

#### SEM Photo @ Post 4000 hr



#### SEM Photo @ Post 4000 hr

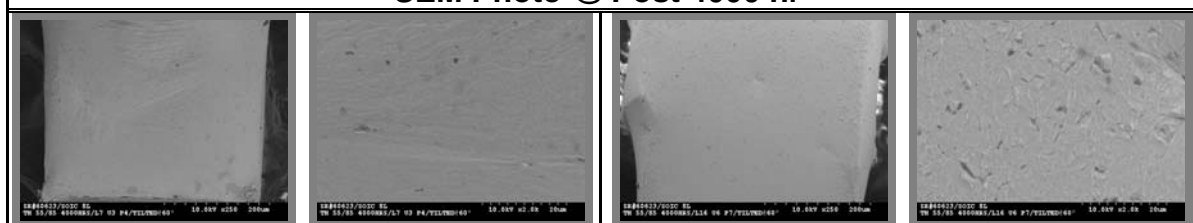


## WHISKER TEST REPORT (FINAL REPORT)

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

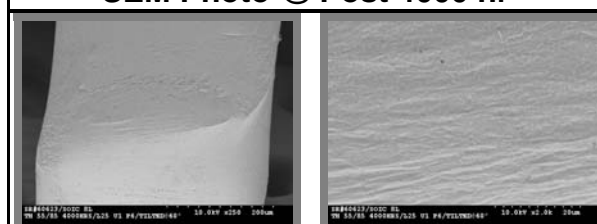
Lot No.	Component # / Termination #	Readpoints				
		0 hr	1000 hr	2000 hr	3161 hr	4000 hr
Lot-1	Comp # <u>3</u> / Term # <u>4</u>	none	none	none	none	none
Lot-2	Comp # <u>6</u> / Term # <u>7</u>	none	none	none	none	none
Lot-3	Comp # <u>1</u> / Term # <u>6</u>	none	none	none	none	none

**SEM Photo @ Post 4000 hr**



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



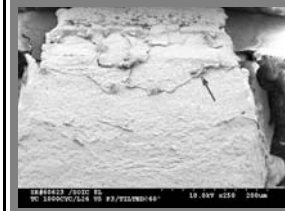
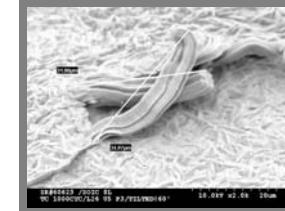


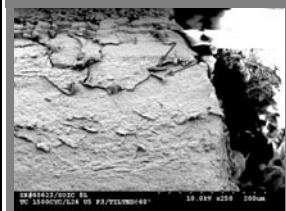

Lot-3: No whisker observed
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### 5.3.8. Thermal Cycling (-55/85°C) post 215°C simulated reflow

Lot No.	Component # / Termination #	Readpoints			
		0 cyc	500 cyc	1000 cyc	1500 cyc
Lot-1	Comp # <u>2</u> / Term # <u>2</u>	none	29.54µm	29.82µm	30.11µm
	Comp # <u>3</u> / Term # <u>2</u>	none	24.64µm	32.91µm	33.56µm
Lot-2	Comp # <u>3</u> / Term # <u>3</u>	none	22.69µm	23.03µm	31.52µm
	Comp # <u>6</u> / Term # <u>5</u>	none	23.68µm	-	-
	Comp # <u>6</u> / Term # <u>1</u>	none	-	30.49µm	35.11µm
Lot-3	Comp # <u>1</u> / Term # <u>1</u>	none	19.25µm	25.30µm	26.37µm
	Comp # <u>5</u> / Term # <u>2</u>	none	19.47µm	-	-
	Comp # <u>5</u> / Term # <u>3</u>	none	-	34.97µm	38.40µm

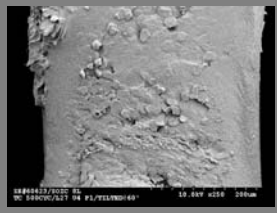

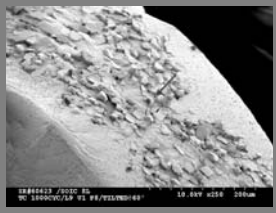

SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 29.54µm		Longest whisker growth of 34.97µm	

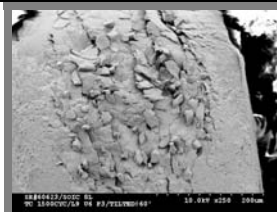

SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 38.40µm	

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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>8</u>	none	14.19µm	21.65µm	-
	Comp # <u>5</u> / Term # <u>7</u>	none	13.09µm	17.95µm	-
	Comp # <u>5</u> / Term # <u>6</u>	none	-	-	25.31µm
	Comp # <u>6</u> / Term # <u>3</u>	none	-	-	27.08µm
Lot-2	Comp # <u>4</u> / Term # <u>4</u>	none	12.08µm	-	-
	Comp # <u>5</u> / Term # <u>3</u>	none	9.98µm	-	-
	Comp # <u>3</u> / Term # <u>1</u>	none	-	20.24µm	22.90µm
	Comp # <u>5</u> / Term # <u>2</u>	none	-	16.32µm	18.49µm
Lot-3	Comp # <u>4</u> / Term # <u>1</u>	none	15.39µm	18.37µm	19.26µm
	Comp # <u>6</u> / Term # <u>3</u>	none	12.63µm	13.23µm	-
	Comp # <u>6</u> / Term # <u>4</u>	none	-	-	20.14µm

SEM Photo @ Post 500 cyc		SEM Photo @ Post 1000 cyc	
			
Longest whisker growth of 15.39µm		Longest whisker growth of 21.65µm	

SEM Photo @ Post 1500 cyc	
	
Longest whisker growth of 27.08µm	

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## 5.4. Appendix

### 5.4.1. Inspection Equipment

#### 5.4.1.1. Optical Microscope

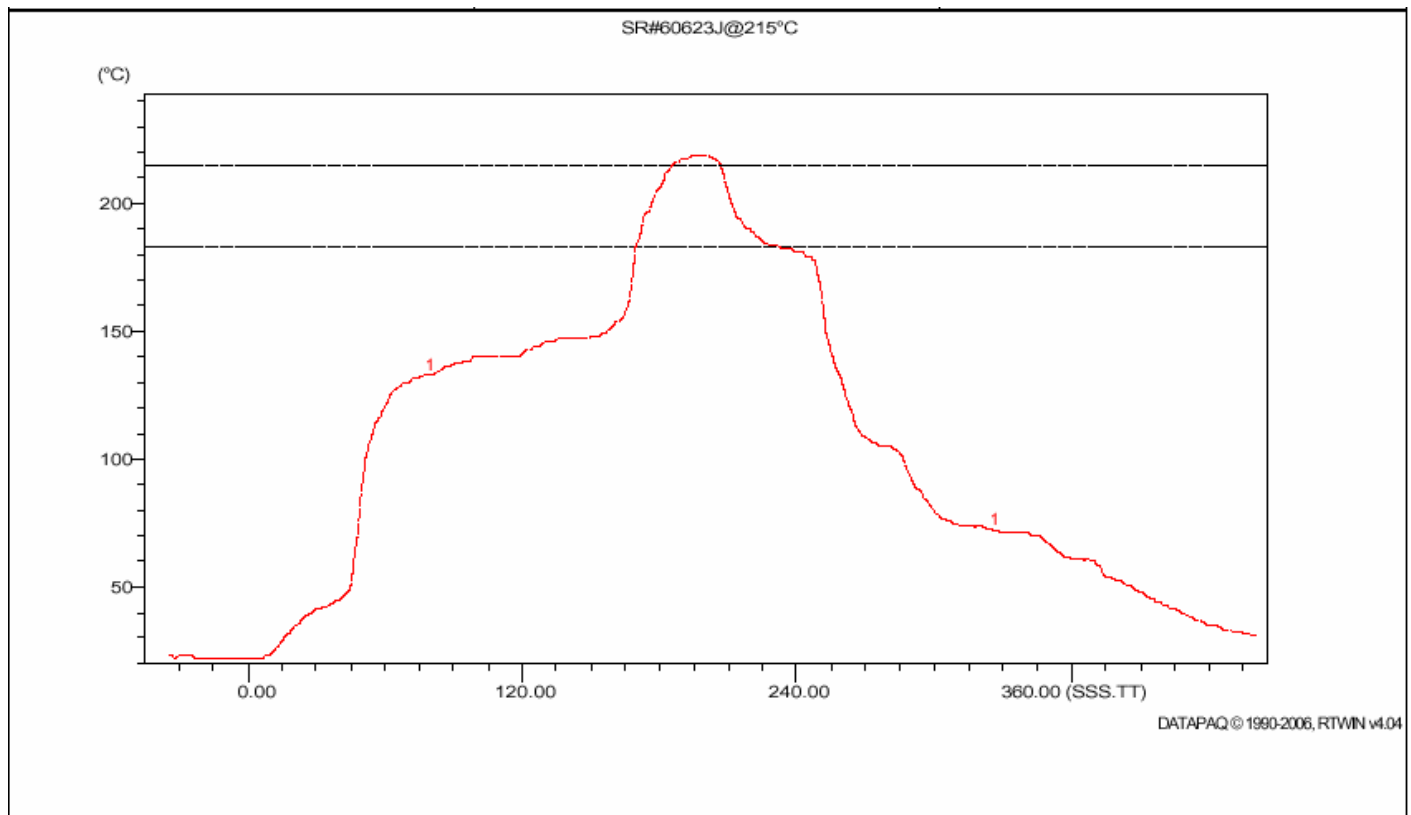
Instrument maker : Olympus  
Model number : SZ40  
Magnification : 40-60x

#### 5.4.1.2. SEM

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

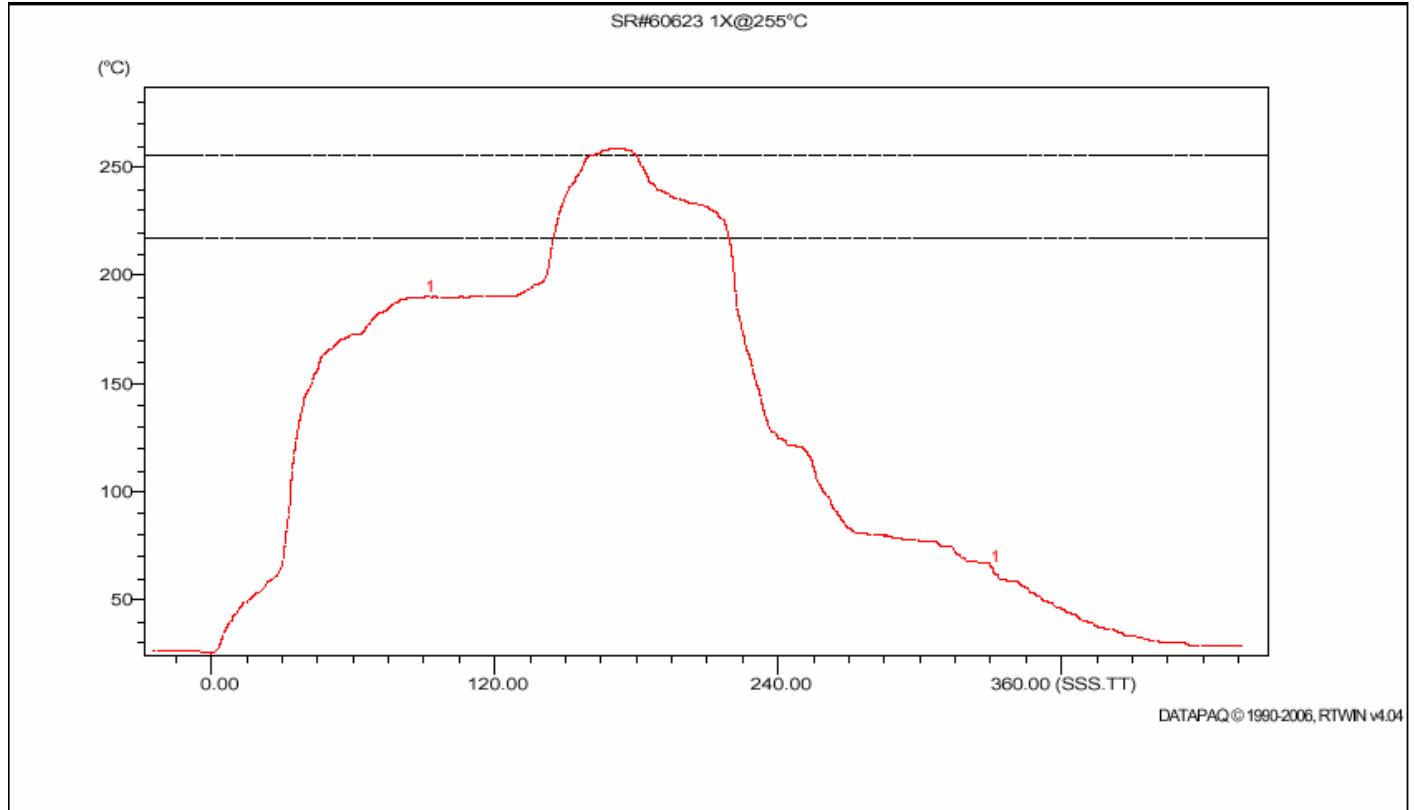
### 5.4.2. Reflow Profiles

#### 5.4.2.1. Simulated 215°C Reflow



# WHISKER TEST REPORT (FINAL REPORT)

## 5.4.2.2. Simulated 255°C Reflow



# WHISKER TEST REPORT (FINAL REPORT)

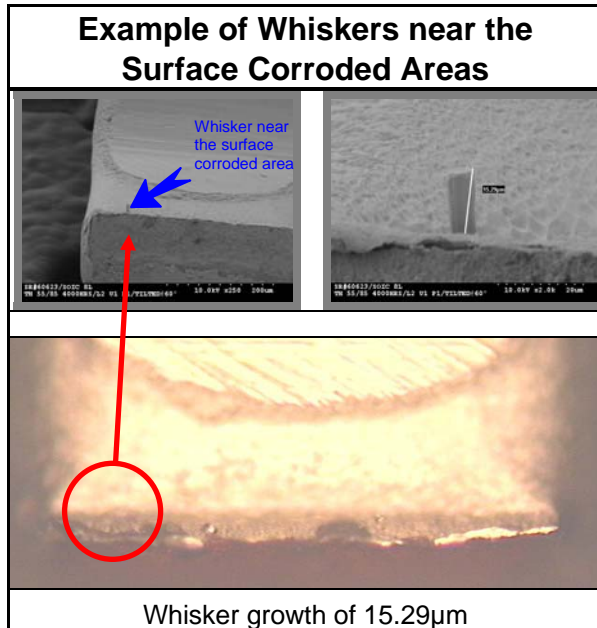
## 5.4.3. Verification Results of Terminations with Surface Corrosion

### 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 (55°C/85%RH)



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## WHISKER TEST REPORT (FINAL REPORT)

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

