

Lead-Free, No-Clean,
Low Silver & High Reliability Solder Paste

ECOSOLDER® PASTE

M40-LS720 series

Technical Data Sheet

- ▶ Description
- ▶ Main Features & Benefits
- ▶ Balance chart compared to previous SAC305 paste
- ▶ Properties of M40 Solder Alloy & Reliability of solder joint
 - Basic properties (Mechanical, Melting temp, Wet ability, etc.)
 - Reliability of solder joint in Thermal cycle
 - Reliability of solder joint in Drop test
- ▶ Physical properties of M40-LS720 paste
 - Viscosity, TI, Stability
 - Printing properties
 - Cold & Hot Slump
 - Tack force & time
 - Solder Ball
 - Solderability compared to previous SAC305 paste
 - Head in Pillow capability
 - Spread ratio
- ▶ Chemical properties
 - Copper mirror, Copper plate corrosion, Fluoride spot test
- ▶ Electrical properties
 - Electrochemical Migration Test
- ▶ Processing guidelines
 - Recommended storage & handling procedure
 - Recommended setting in print process
 - Recommended reflow profile
- ▶ Technical data sheet

NOT FOR PRODUCT SPECIFICATION

This technical information contained herein is intended for reference only. It is not intended, and shall not be construed, to warrant or guarantee the performance of the products described which are sold subject exclusively to written warranties and limitation thereon included in product packaging and invoices.

Description

Senju Ecosolder® paste M40-LS720 is a Low Silver lead-free solder paste which has been formulated as the coming generation of solder paste to save soldering cost strongly desired SMT market.

Sometimes both negative property of low silver solder such as deterioration of thermal fatigue property and rising of melting temperature have obstructed the introduction of low silver solder paste into SMT.

However, **Ecosolder® paste M40-LS720** conquered these obstructions with optimizing solder alloy composition, also can stand comparison with previous SAC305 (Senju M705) solder paste in all soldering ability by designing exclusive chemical flux.

Previous obstructions
to introduce low-silver solder paste

- ✓ Rising of Melting temperature
- ✓ Deterioration of joint strength in Thermal cycle.



Optimizing alloy composition
Development exclusive flux

Main Features & Benefits

- **Cost saving**
- **Same process window (Print & Reflow) & Quality as SAC305 solder paste.**
- **Same or more high reliability of solder joint as SAC305 solder paste.**
- **Reducible Head in Pillow, Tombstone problem.**
- **High yield in AOI, ICT process and Excellent Flux cosmetics after reflow.**

Product information

ECOSOLDER® PASTE

M40-LS720 Type4

Solder Alloy code

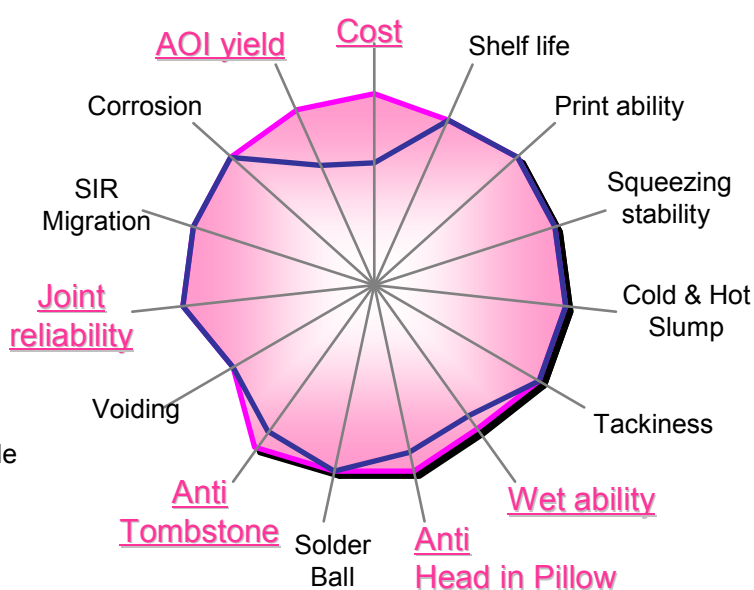
Flux Code

Powder Type
(ANSI/J-STD-005 classification)

*Based upon Type4 powder, other sizes also available

Balance chart

M40-LS720 / Previous SAC305 solder paste

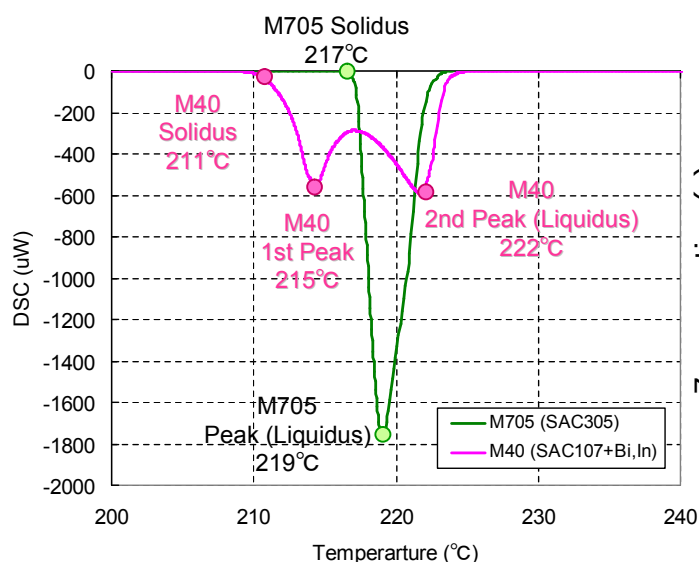


■ M40-LS720

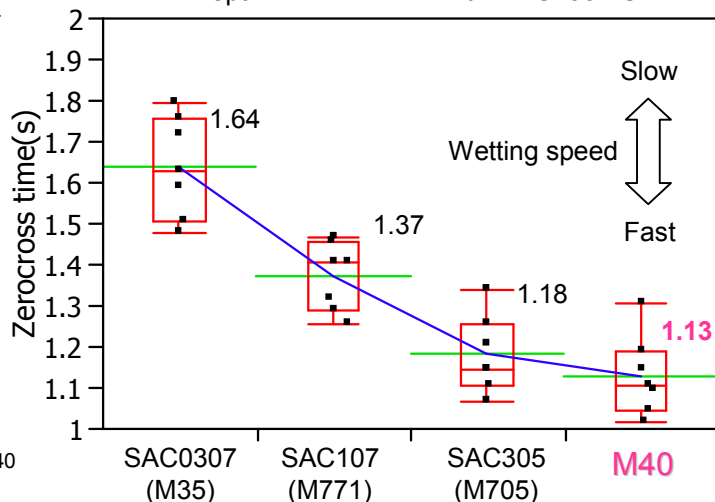
■ Previous SAC305 (M705) paste

Properties of M40 solder alloy

Solder alloy code		M40	M705
Alloy composition		Sn-1.0Ag-0.7Cu-Bi-In	Sn-3.0Ag-0.5Cu
Melting Temperature (°C (°C))	Solidus	211	217
	Melting peak	1 st : 215 / 2 nd : 222	219
	Liquidus	222	219
Tensile strength (MPa)		59.4	47.8
Elongation (%)		62.8	79.8
Poisson ratio		0.35	0.35
CTE		21.3	21.7
Patent No.		JP3753168	JP3027441

Melting temperature (DSC Curve)Comparison of zero cross time M40 & SAC series solder

Condition Coupon: Cu plate Solder Bath: 250°C
Depth: 4mm Flux: ES1061-SP

Difference of melting behavior

- Solidus 6°C lower and Liquidus 2°C higher than SAC305
- Twin peak melting is controllable Tombstone issue.

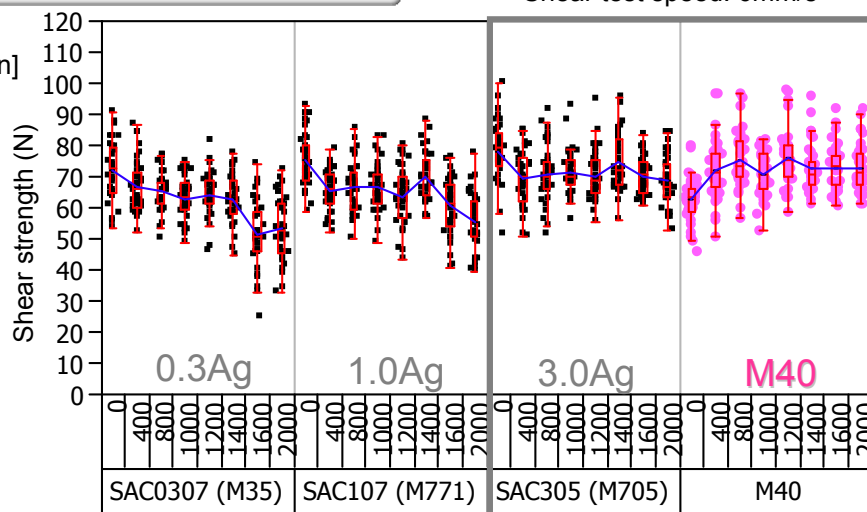
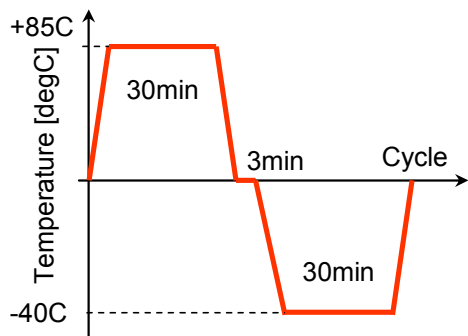
Wetting performance

- Faster wetting speed than typical Low Silver alloy.
- Same or Faster than SAC305 alloy.

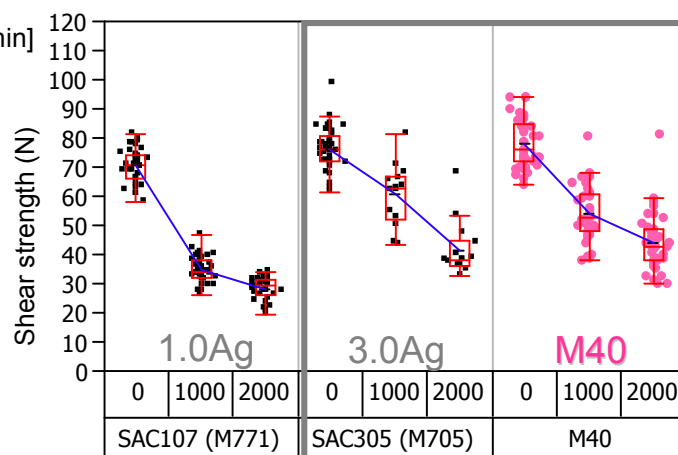
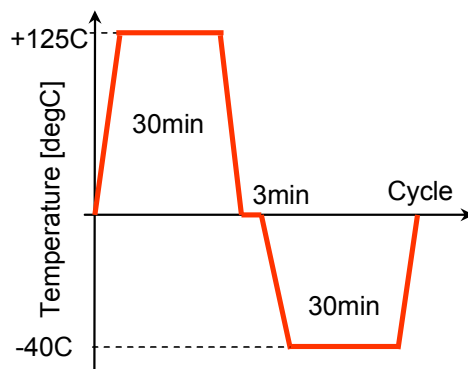
Long term reliability of solder joint during thermal cycle stress

Test device: 3216chip resistor
Shear test speed: 6mm/s

[TCT condition: -40~+85°C Keep time: 30min]

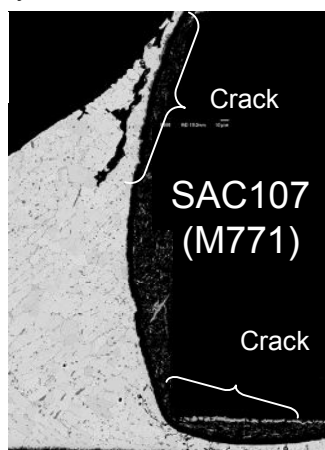


[TCT condition: -40~+125°C Keep time: 30min]

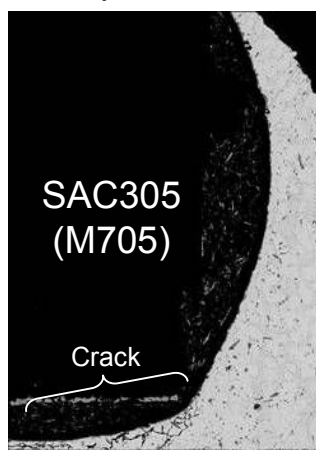
Cross section image after thermal cycle stressDurability in TCT

- Equal to or higher than SAC305

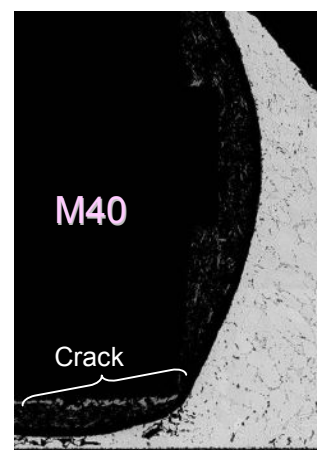
Thermal cycle condition: -40~+85°C after 2000cycle



Cracks were observed
at under chip & top side.



Cracks stagnant
under chip area



Cracks stagnant
under chip area

Reliability of solder joint in Drop test

Test condition:

Test device: 12x12mm BGA

Electrode finish: ① Electrolytic Ni/Au
② Cu-OSP

Sphere: ① SAC105 (M34)
② SAC305 (M705)

PCB: 30x120x0.8t mm

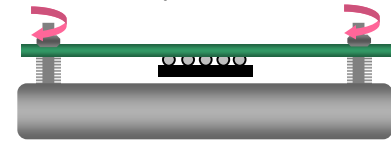
Surface finish: Cu-OSP (NSMD)

Solder alloy of SMT solder paste:

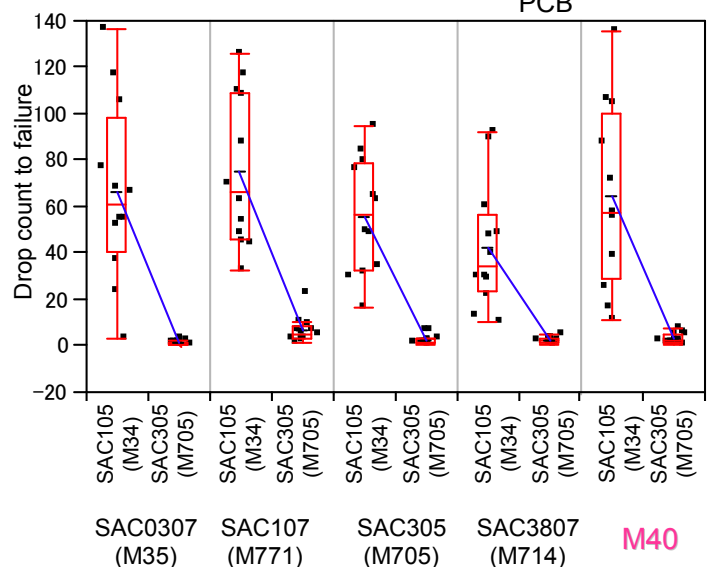
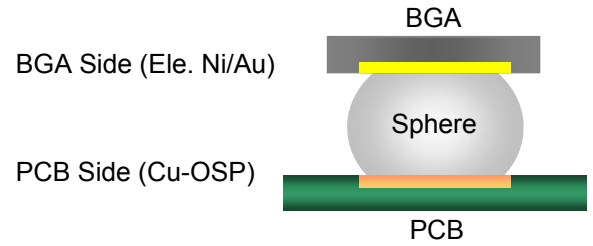
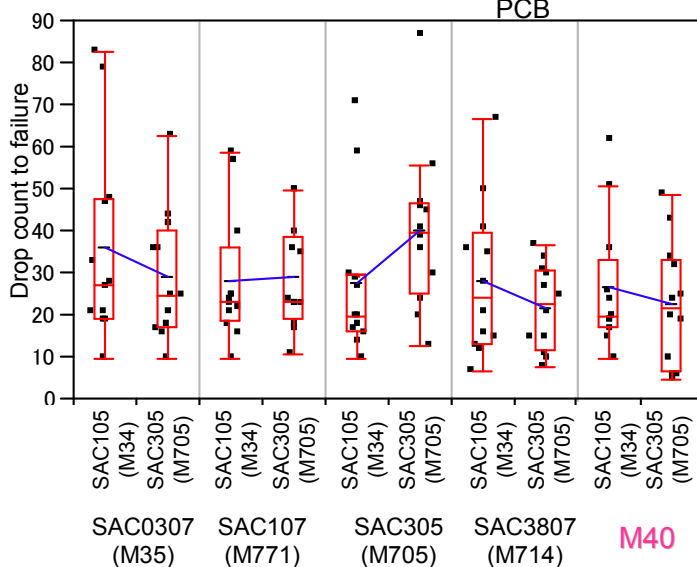
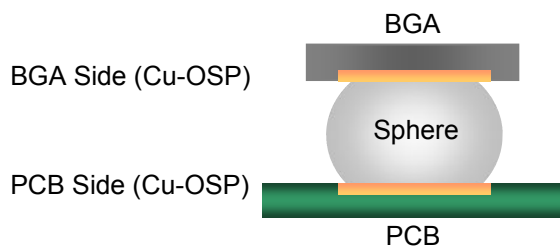
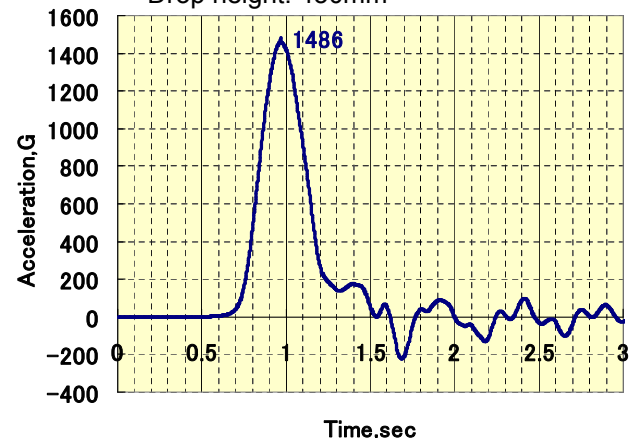
- ① SAC0307 (M35)
- ② SAC107 (M771)
- ③ SAC305 (M705)
- ④ SAC3807 (M714)
- ⑤ M40



Torque: 15cN·m



Maximum acceleration: around 1500G
Drop height: 450mm

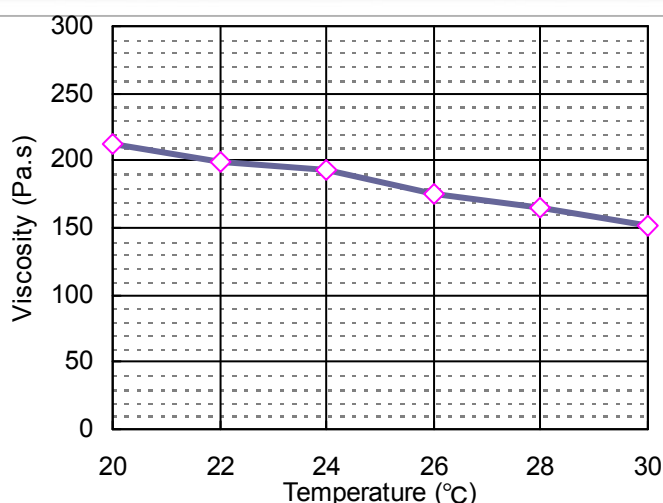


Reliability of solder joint in Drop test

- Drop reliability is clearly controlled by the combination of sphere composition & electrode finish rather than SMT paste.
- M40 solder paste does not bring about negative result compared to typical SAC solder paste.

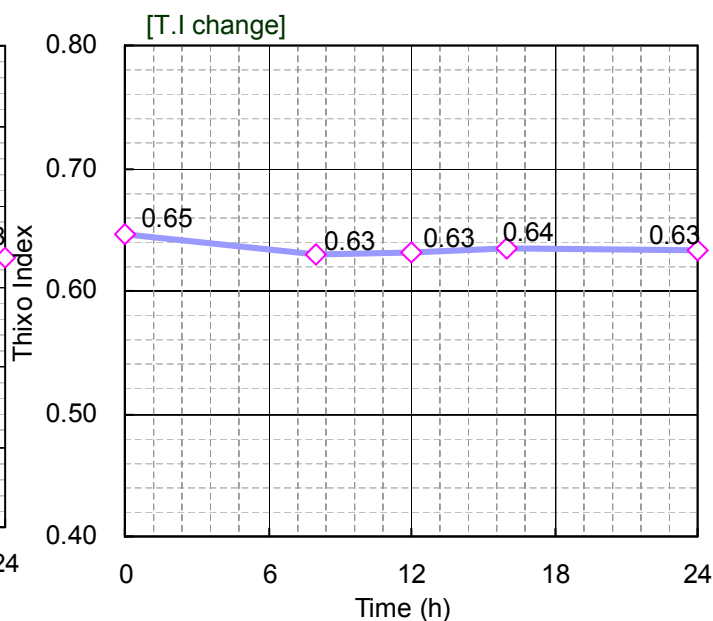
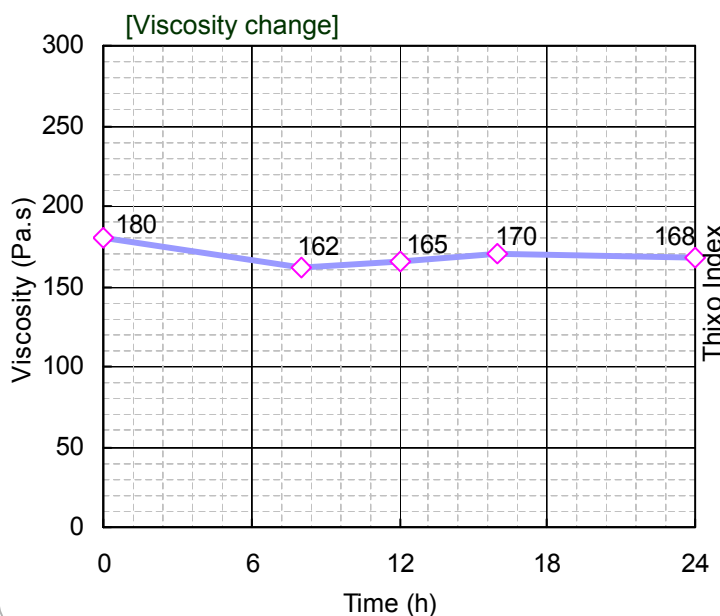
Viscosity with temperature

Viscometer: Malcom PCU
 Rotate speed: 10rpm
 Temperature: 20, 22, 24, 26, 28, 30°C



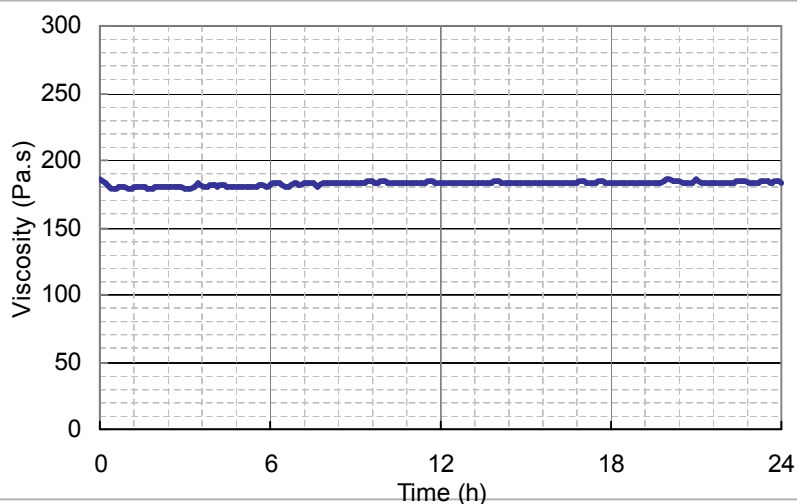
Viscosity & Thixotropic Index change with continuous printing

Squeezing tact: 30sec/Shot
 Test environment: 25°C50%RH



Viscosity stability with continuous measurement in viscometer

Viscometer: Malcom PCU
 Rotate speed: 10rpm
 Temperature: 25°C



Printing properties

Test condition:

Stencil: SUS Laser cut / 120umt

Squeegee: Metal

Angle: 60°

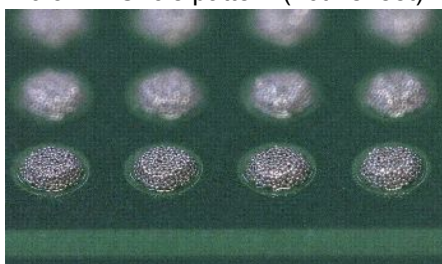
Speed: 40mm/s

Pressure: 0.25N/mm

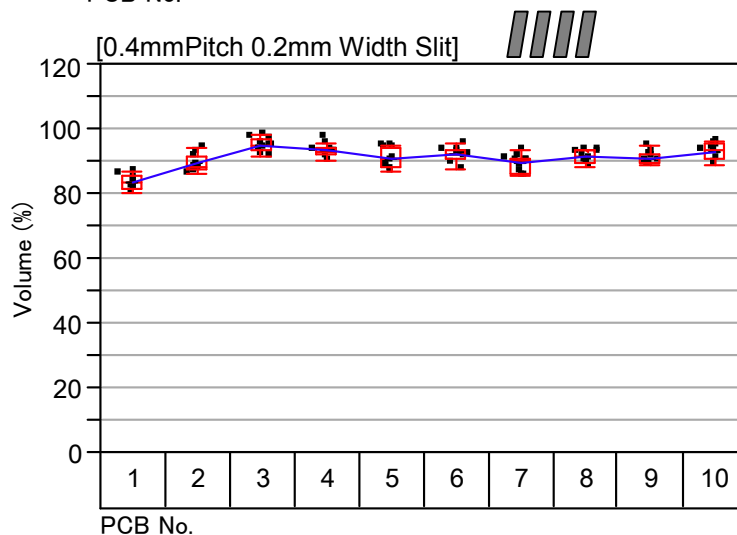
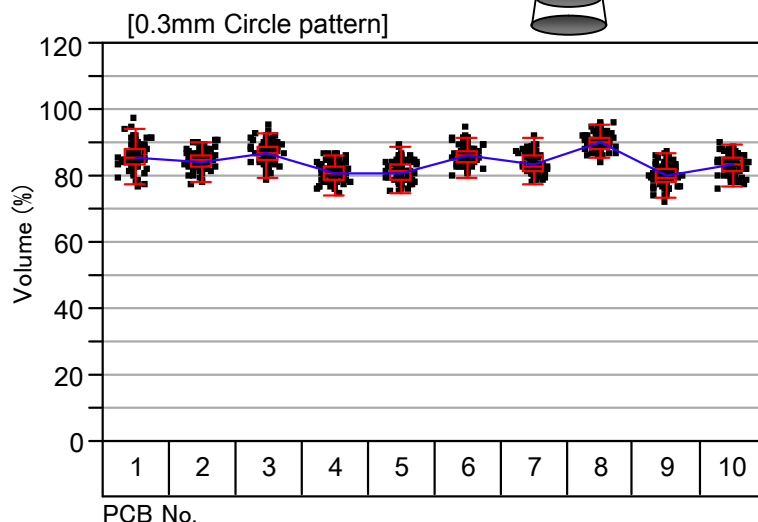
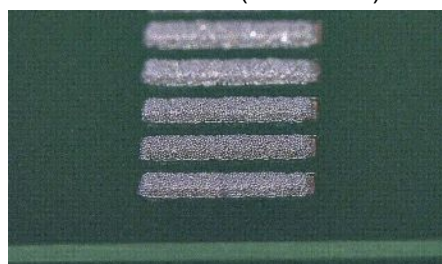
Separation speed: 5.0mm/s(Fixed mode)

Environment: 25°C50%RH

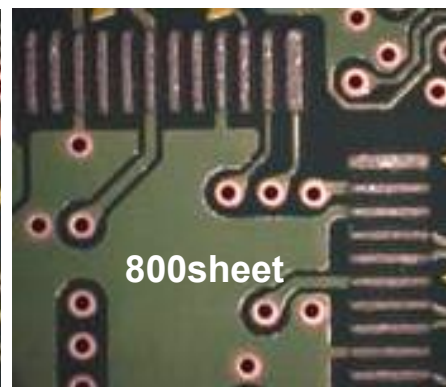
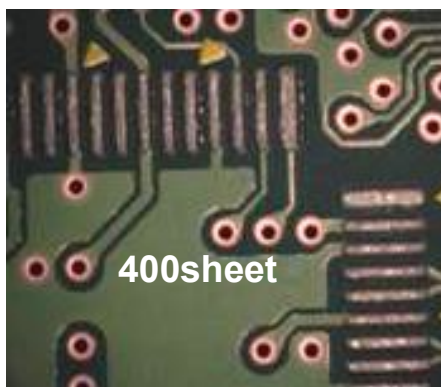
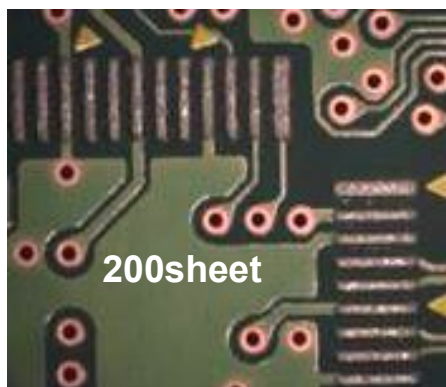
0.3mm Circle pattern (10th sheet)



0.4mm Pitch Slit (10th sheet)



Long term printing properties



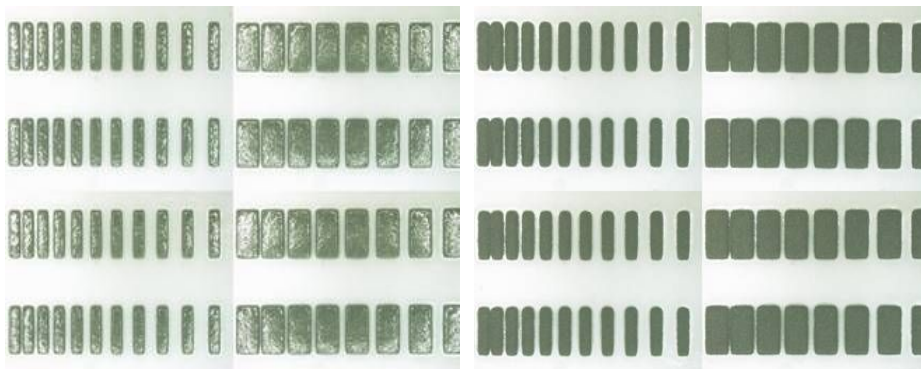
Printing properties

- Excellent print consistency for a broad range of aperture size.

Cold slump & Hot Slump

Procedure: JIS Z 3284
 Thickness: 200um
 Temp & time in hot slump test:
 180°Cx 3min

Cold slump: < 0.2mm
 Hot slump: < 0.3mm

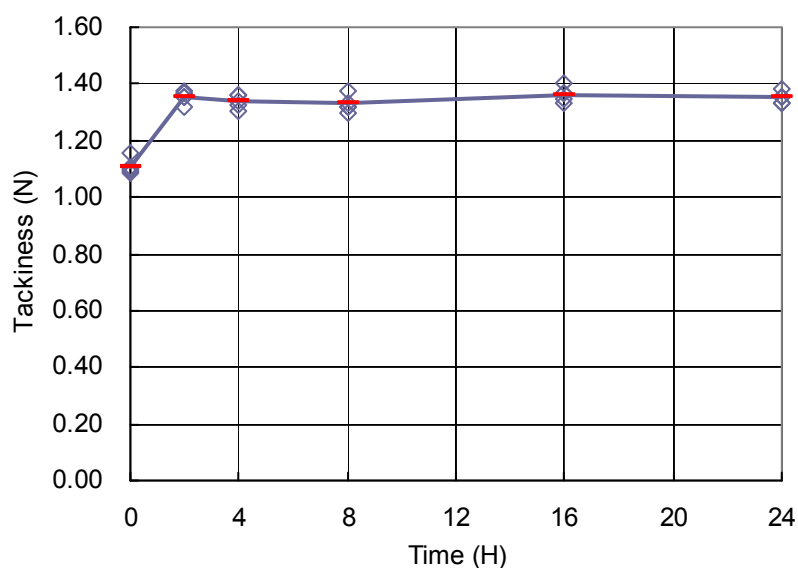


Cold slump

Hot slump
3min@180°C**Tack force & Time**

Procedure: JIS Z 3284
 Equipment: RHESCA TAC-II
 Thickness: 200um
 Press time: 0.2s
 Immersion speed: 2.0mm/s
 Press load: 0.49N
 Test speed: 10.0mm/s
 Environment: 25°C50%RH

Initial tack force: over 1.1N
 Keep time above 1.0N: over 24h

**Solder ball test**

Procedure: JIS Z 3284
 Heating: 270°C solder bath
 Thickness: 200um
 Environment: 25°C50%RH

Initial



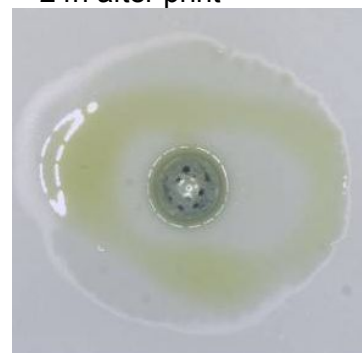
Rank 1

4h after print



Rank 1

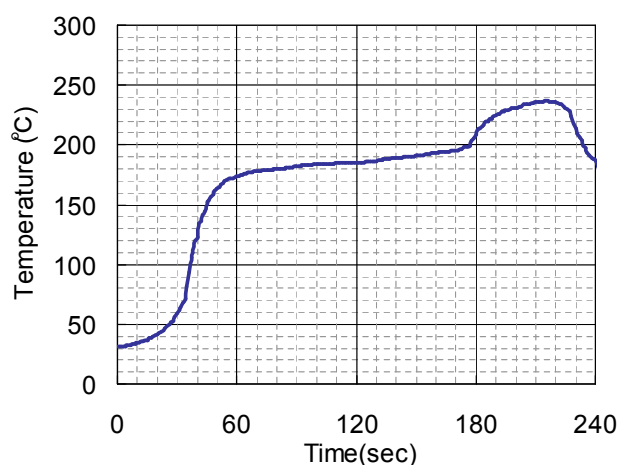
24h after print



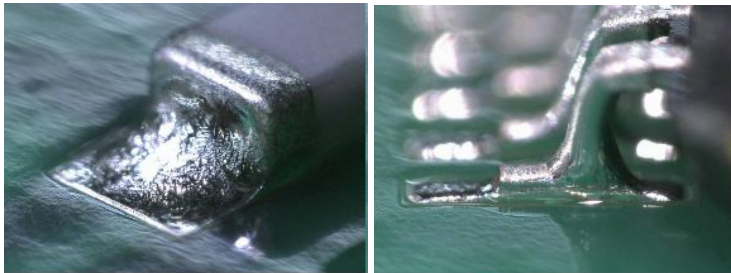
Rank 1~2

Solderability compared to previous SAC305 solder paste

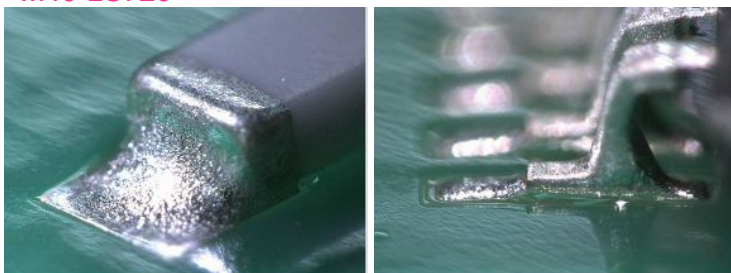
Pad finish: Cu-OSP
 Device: Chip capacitor (Sn)
 (Plating) QFP (Sn)
 Stencil thickness: 120um
 Reflow atmosphere: AIR
 Reflow profile: Below
 Peak temp: 236°C



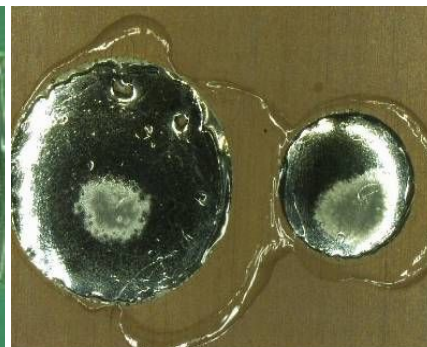
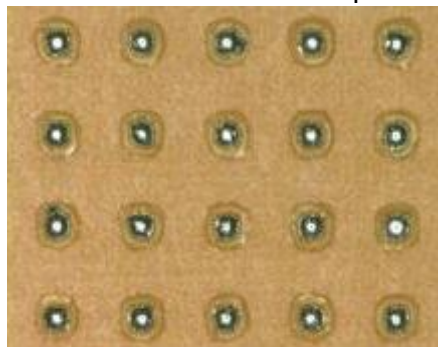
Previous SAC305 solder paste



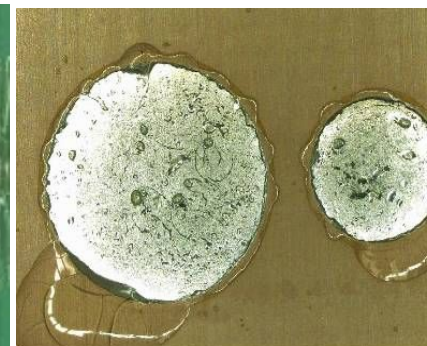
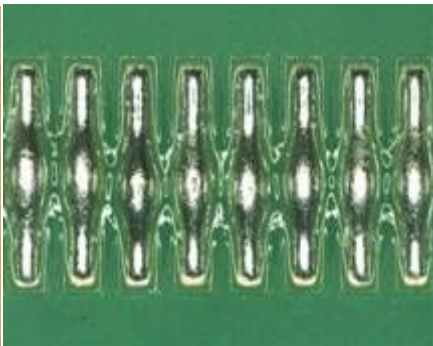
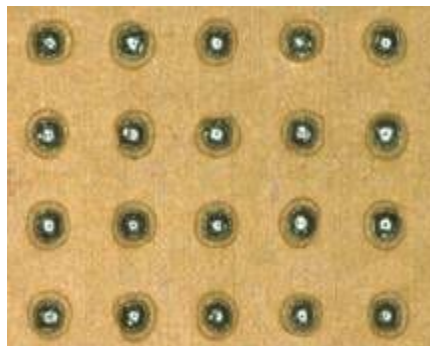
M40-LS720



Previous SAC305 solder paste



M40-LS720



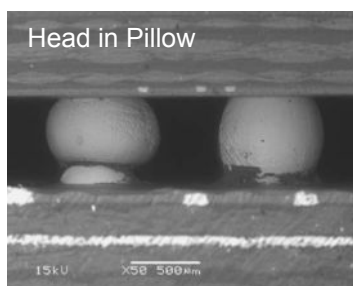
Small deposit (200um Φ)

Slit pattern (0.5mm Pitch)

Large aperture (5mm Φ, 3mm Φ)

- Equal solderability compared to previous SAC305 solder paste.
- M40 solder has a Mat surface finish after solidified which will bring about high yield in AOI process.

Prevention of Head in Pillow issue

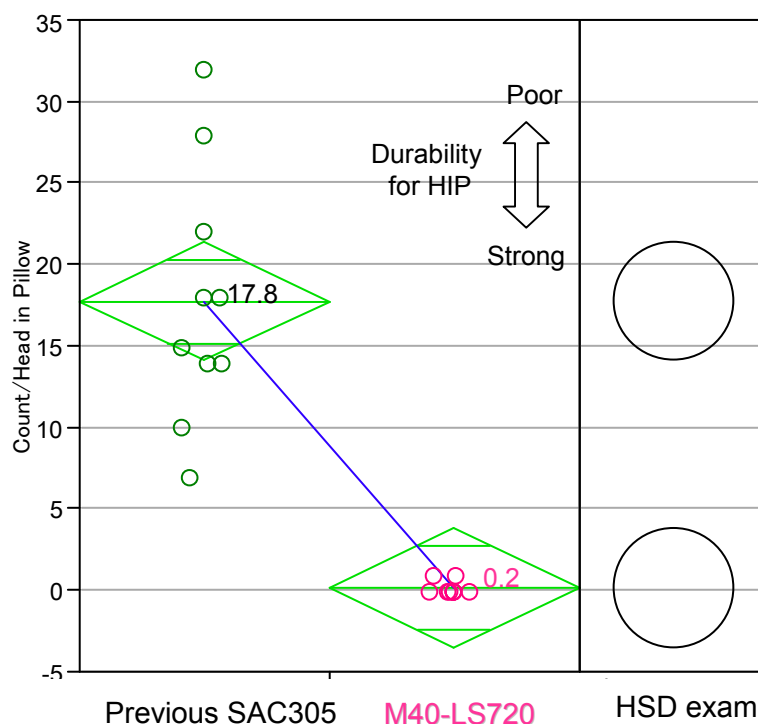
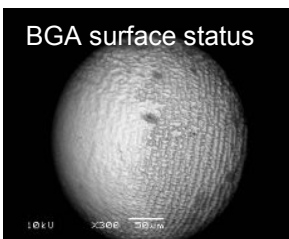
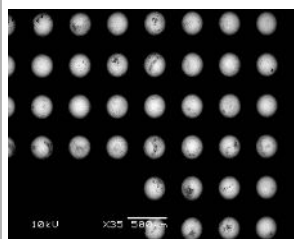


Accelerated test condition:

BGA: 0.5mmPitch SAC305 sphere

Precondition: Immerse WS flux 2.5% IPA
+48H@85°C85%RH oxidized

Reflow: Preheating 180~205°C 100sec
Peak temp 225°C (TAL220°C 15sec)



- Strongly preventable HIP issue compared to previous SAC305 paste.
(This result was obtained by Senju's original accelerated test condition.)

Spread properties compared to SAC305 products

Procedure: JIS Z 3197
Coupon: Oxidized Cu plate
Paste amount: 0.3g
Heating: 270°C solder bath

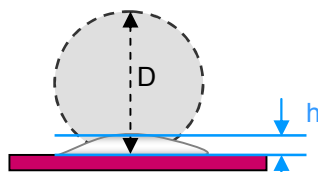
50x50x0.5mm Cu plate



Paste supplied



After reflow



Calculation of spread ratio
Spread ratio(%)
= (D - h) / D x 100

Sample	Spread ratio (%)					
	1	2	3	4	5	Average
Previous SAC305	77.23	76.89	78.10	76.31	78.14	77.3
M40-LS720	79.19	79.02	79.88	78.95	79.42	79.3

- Equal or more spread properties compared to previous SAC305 products.

Cooper mirror corrosion

Procedure: JIS Z 3197

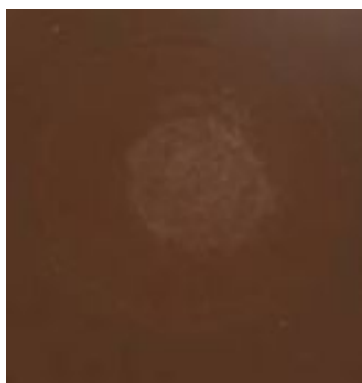
Control material: WW rosin 25% IPA solution

Test material: LS720 flux 25% IPA solution

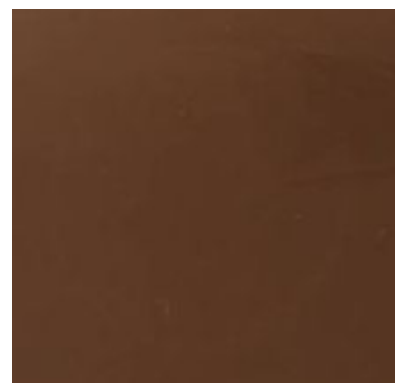
Temp & Time: 24H@25°C50%RH

Result: Pass

No evidence of mirror breakthrough



WW rosin solution

**M40-LS720**Copper plate corrosion

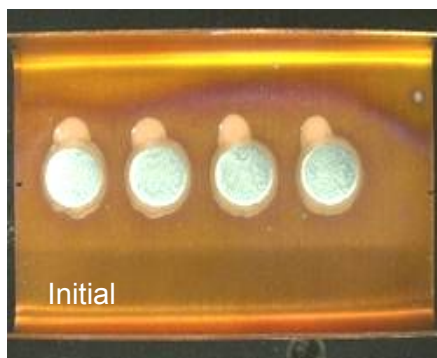
Procedure: JIS Z 3197

Temp & Time: 72H@40°C90%RH

Result: Pass

No evidence of corrosion

Soldered side



Initial

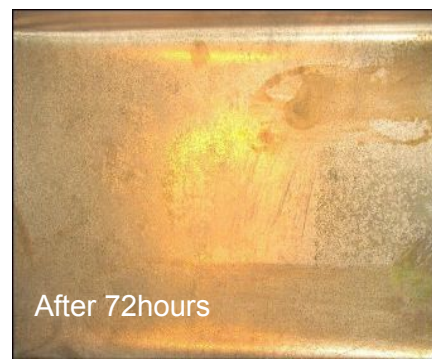


After 72hours

Cover side



Initial



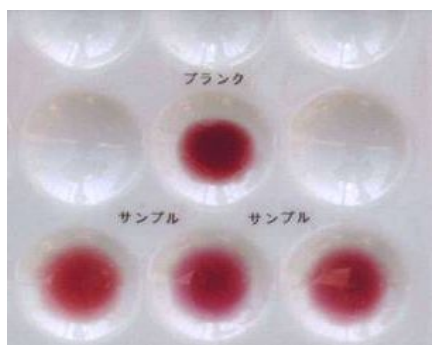
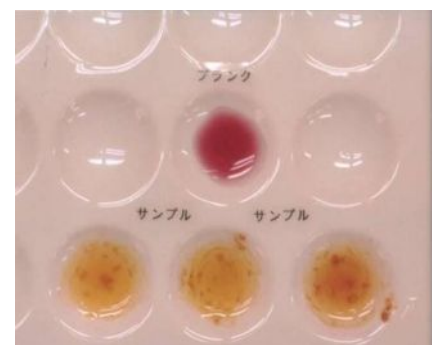
After 72hours

Fluoride spot test

Procedure: JIS Z 3197

Result: Pass

No evidence of color change

**M40-LS720**

NG Sample (ref)

Electrochemical Migration test

Procedure: JIS Z 3284

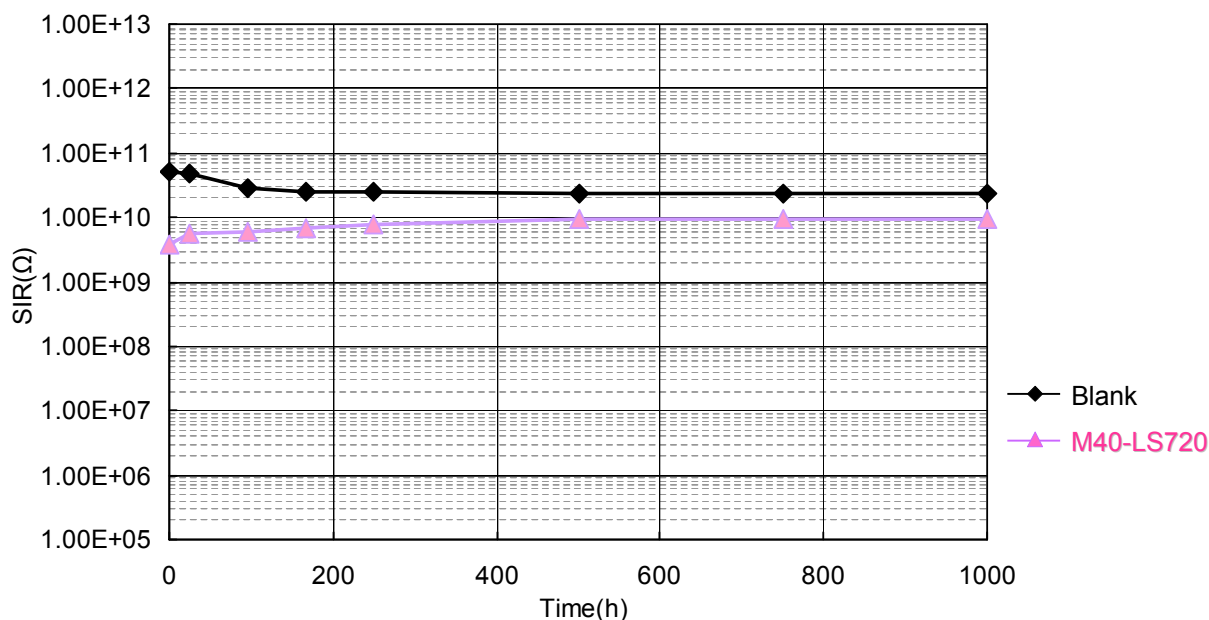
Test PCB: JIS-2 comb pattern Test time: 1000h

Print thickness: 0.1mm

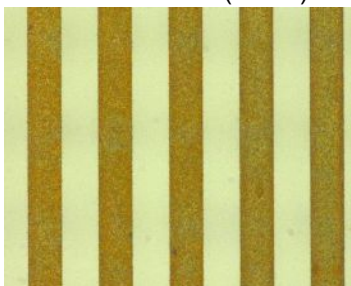
Environment: 85°C85%RH

Measuring voltage: DC100V

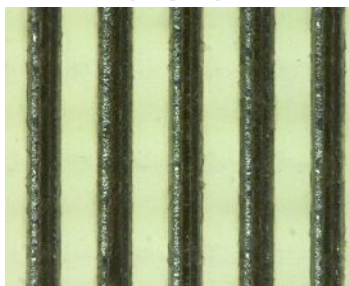
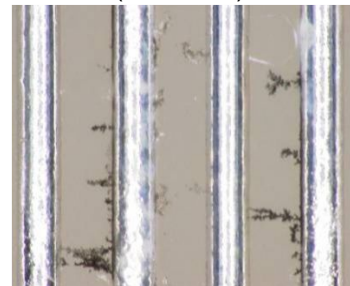
Applied voltage: DC45V



Sample	Time (H)	Environment	CHANNEL			AVERAGE Resistance
			1	2	3	
Blank	0	85C85%RH	1.01E+10	1.24E+11	1.10E+11	5.16E+10
	24		5.53E+10	4.89E+10	3.92E+10	4.74E+10
	96		3.28E+10	2.99E+10	2.48E+10	2.89E+10
	168		3.04E+10	2.58E+10	2.16E+10	2.56E+10
	250		3.37E+10	2.48E+10	2.04E+10	2.58E+10
	500		2.94E+10	2.36E+10	1.86E+10	2.34E+10
	750		2.93E+10	2.34E+10	1.84E+10	2.33E+10
	1000		2.94E+10	2.33E+10	1.83E+10	2.33E+10
M40-LS720	0		5.19E+09	3.97E+09	2.59E+09	3.76E+09
	24		4.75E+09	5.56E+09	6.97E+09	5.69E+09
	96		5.41E+09	5.54E+09	6.88E+09	5.91E+09
	168		7.13E+09	5.85E+09	7.10E+09	6.66E+09
	250		7.64E+09	6.59E+09	8.53E+09	7.54E+09
	500		8.87E+09	9.08E+09	1.11E+10	9.63E+09
	750		8.69E+09	9.28E+09	1.11E+10	9.63E+09
	1000		8.85E+09	9.12E+09	1.11E+10	9.63E+09

 Comb pattern status after testing
 Control PCB (Blank)


M40-LS720


 NG sample
 (reference)


Result: Pass
 No generation of migration

Storage & Handling

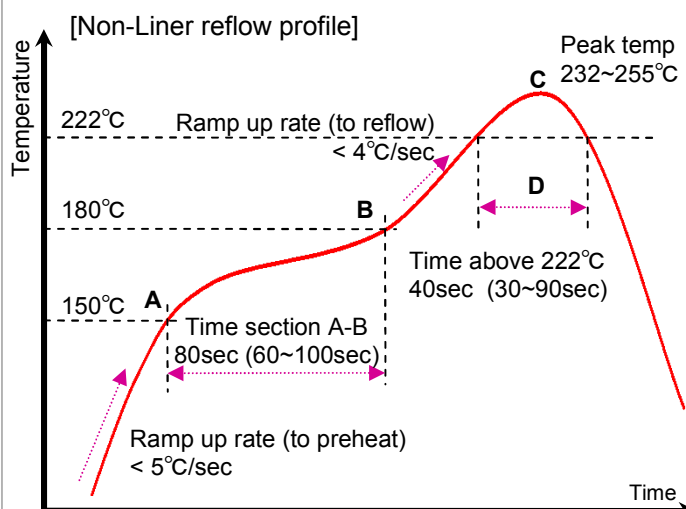
Item	Recommended procedure	Remark
Storage	6month at refrigerated 0 ~ 10°C	Without unsealing condition
Warm-up prior to use	At least 1hour leaving at ambient working temp	Do not use forced heating methods. Actual paste temp should be verified
Capable storage period at room temperature prior to use	1 week	Without unsealing condition
Stirring before processing	Manual: 30 ~ 60sec Automatic: 30 ~ 60sec*	*Depend on stir rate of stirring machine (Caution against surplus stir)
Working environment	Temperature: 22 ~ 28°C Related humidity: 30 ~ 70%RH	— — —
Capable working time in continuous printing	24 hours	Do not mix worked paste with unused paste
Capable abandon time in printing process	1 hour	— — —
Capable idle time before placement after print	8 hours	— — —
Capable idle time before reflow after print	8 hours	— — —
Re-storage of remaining paste in container (unused portion)	0 ~ 10°C	Allowed to re-storage 1time in validity with putting the lid on firmly.

Recommend setting in printing process

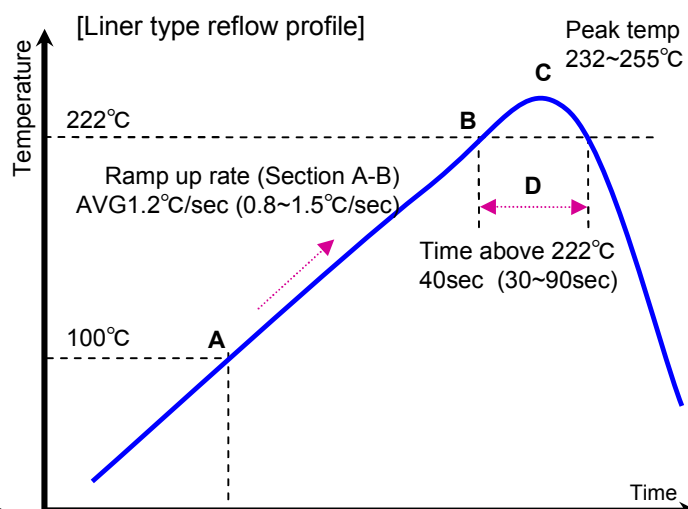
Item	Recommended procedure	Capable
Printer types	Open squeegee model	Enclosed squeegee system
Squeegee blade	Metal	Urethane, Plastic
Squeegee angle	60°	45 ~ 60°
Printing speed	30 ~ 50mm/s	20 ~ 100mm/s
Printing pressure	0.20 ~ 0.30N/mm	Adjust not to leave paste on stencil
Separation speed	1.0 ~ 5.0mm/s	< 10mm/s
Paste rolling diameter	10 ~ 15mm	— — —
Temperature & Humidity	22 ~ 28°C 30 ~ 70%RH	— — —

Recommended Reflow profile

M40-LS720 paste is formulated for using in AIR reflow process. But we also recommend using Nitrogen reflow to obtain higher soldering quality and stability.



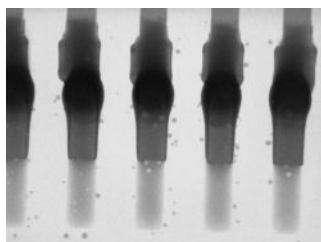
Point		Lower limit	Recom-mend	Upper Limit
A	Soak zone start	140°C	150°C	160°C
B	Soak zone end	160°C	180°C	200°C
A-B	A-B section time	60sec	80sec	100sec
C	Peak temperature	232°C	240°C	255°C
D	Time above 222°C	30sec	40sec	90sec



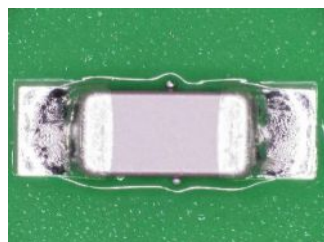
Point		Lower limit	Recom-mend	Upper Limit
A	Soak zone start	---	100°C	---
B	Soak zone end	---	222°C	---
A-B	A-B section time	80sec	100sec	150sec
	Ramp up rate	0.8°C/s	1.2°C/s	1.5°C/s
C	Peak temperature	232°C	240°C	255°C
D	Time above 222°C	30sec	40sec	90sec

Typical soldering issues related to reflow profile (Ref)

[Sudden ramp up to soak zone]

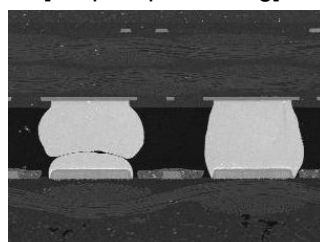


Powder size solder ball



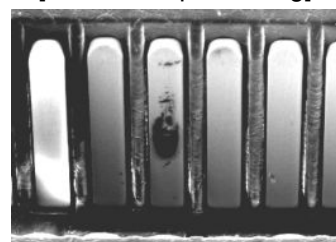
Side ball

[Surplus preheating]



Head in Pillow

[Insufficient preheating]



Flux spattering

[Sudden ramp up to peak zone]

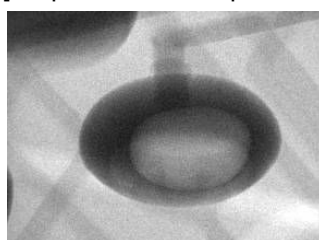


Side ball



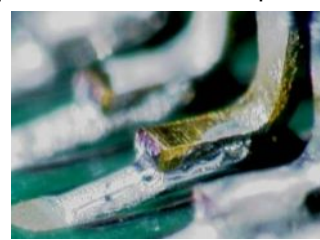
Tombstone

[Surplus reflow temp & time]



Void growth

[Insufficient reflow temp & time]



Insufficient wetting

Technical Data Sheet

Category / Item	Typical data / Abilities	Procedure / Remarks
SOLDER POWDER		
Solder alloy	Sn-1.0Ag-0.7Cu-Bi-In	---
Melting temperature	211 ~ 222°C	DSC
Powder shape	Spherical	SEM
Particle size of powder	Type4 (standard) other sizes also available	J-STD-005 SEM & Laser method
SOLDER PASTE		
CHEMICAL PROPERTIES		
Flux Type / Activity Level	RO / L1	J-STD-004
Presence of Halide	Ag Chromate Test: Pass	J-STD-004
	Fluoride Spot Test: Pass	J-STD-004
Copper Mirror Test	Pass	JIS Z 3197
Copper Corrosion Test	Pass	JIS Z 3197
Halogen content	> 3000ppm	EN14582
ELECTRICAL PROPERTIES		
Surface Insulation Resistance 168H @ 85°C85%RH	Over 1.0E+9 Ω	JIS Z 3284
Electrochemical Migration 1000H @ 85°C85%RH	Over 1.0E+9 Ω No generation of migration	JIS Z 3284
PHYSICAL PROPERTIES		
Viscosity	190 Pa.s	JIS Z 3284 Malcom spiral viscometer
Thixotropic Index	0.60	
Flux Content (Metal Content)	12.0% (88.0%)	JIS Z 3197
Slump	Cold: < 0.2mm, Hot: < 0.3mm	JIS Z 3284
Tack Force & Time	Initial: over 1.1N Keep time above 1.0N: over 24h	JIS Z 3284
Spread Ratio	79%	JIS Z 3197
De-wetting Test	Rank 2	JIS Z 3284
Solder Ball	Rank 1 ~ 2	JIS Z 3284
Shelf Life	6 months	@ 0 ~ 10°C Sealed condition

NOT FOR PRODUCT SPECIFICATION

This technical information contained herein is intended for reference only. It is not intended, and shall not be construed, to warrant or guarantee the performance of the products described which are sold subject exclusively to written warranties and limitation thereon included in product packaging and invoices.