Lead-Free, No-Clean,

Low Silver & High Reliability Solder Paste

ECO SOLDER PASTE

M46-LS720HF series

Technical Data Sheet

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- Technical data sheet

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Description

Senju Ecosolder® paste M46-LS720HF is a Low Sliver lead-free & Halogen 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 M46-LS720HF** 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 Solderability & 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

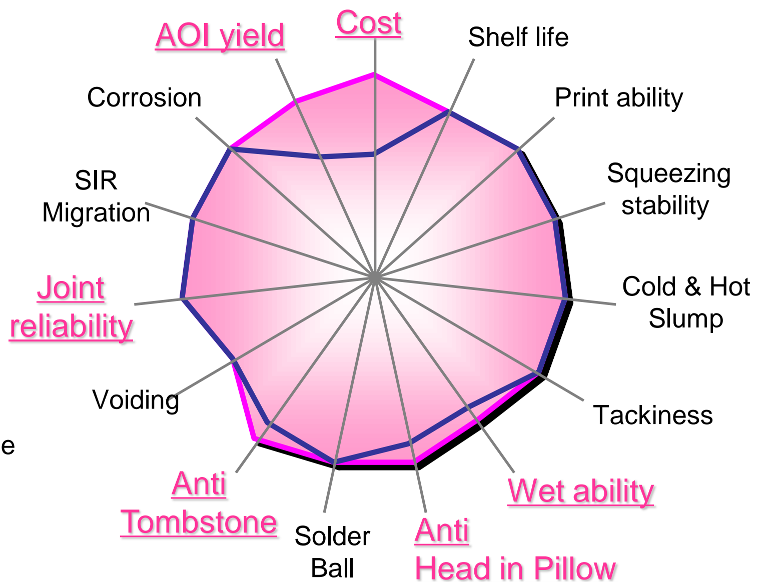
ECO SOLDER PASTE

M46-LS720HF Type4

- Solder Alloy code
- Flux Code
- Powder Type (ANSI/J-STD-005 classification)

*Based upon Type4 powder, other sizes also available

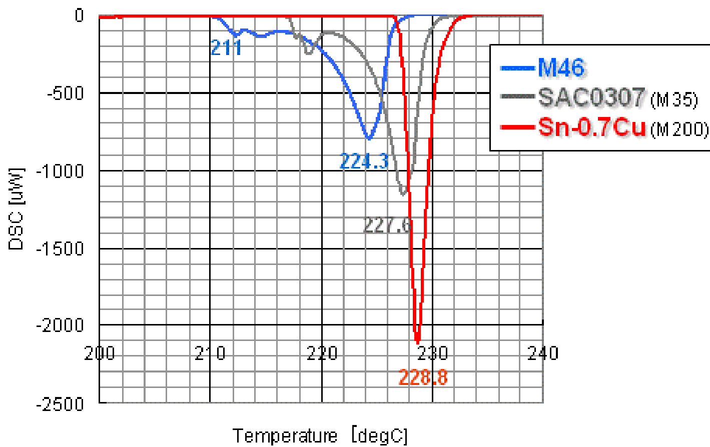
Balance chart M46-LS720HF／Previous SAC305 solder paste



Properties of M46 solder alloy

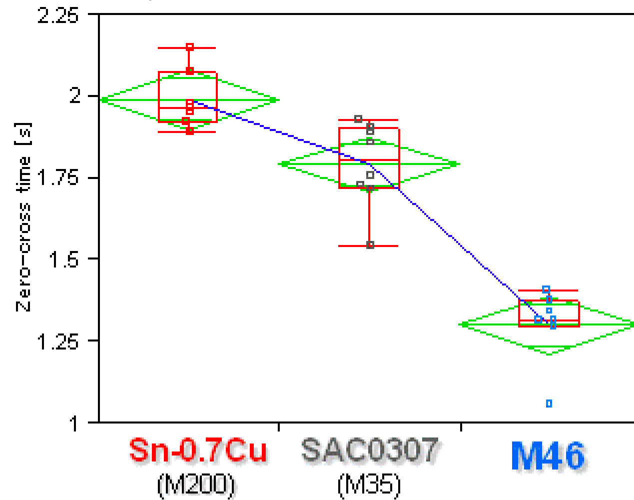
Solder alloy code		M46	M705
Alloy composition		Sn-0.3Ag-0.7Cu-Bi-In-Sb	Sn-3.0Ag-0.5Cu
Melting Temperature (℃(℃)	Solidus	211	217
	Melting peak	225	219
	Liquidus	225	220
Tensile strength (MPa)		55.5	53.3
Elongation (%)		34	55
CTE		21.9	21.7

Melting temperature (DSC Curve)



Comparison of zero cross time M46 & SAC series solder

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



Difference of melting behavior

- Solidus 6℃ lower and Liquidus 6℃ higher than SAC305.

Wetting performance

- Faster wetting speed than typical Low Silver alloy.

Long term reliability of solder joint during thermal cycle stress

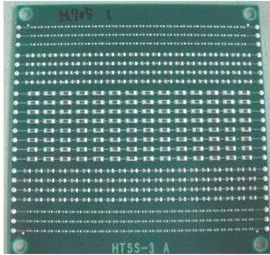
➢ Excellent long term reliability

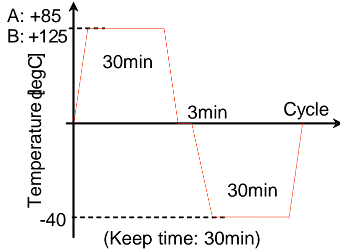
Thermal cycle test condition

Materials:
Test PCB surface finish: CU+OSP
Layers: 2 for TCT condition A, 6 for TCTB
Device: 3216Chip Resistor (Sn plating)
Printing thickness: 120um
Reflow peak temperature: 240degC

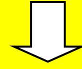
TCT conditions:
A: -40degC / +85degC (Keep time: 30min)
B: -40degC / +125degC (Keep time: 30min)

Measurement of joint strength:
Shear tester : STR-1000
Test speed: 6.0mm/min
Clearance: 10um





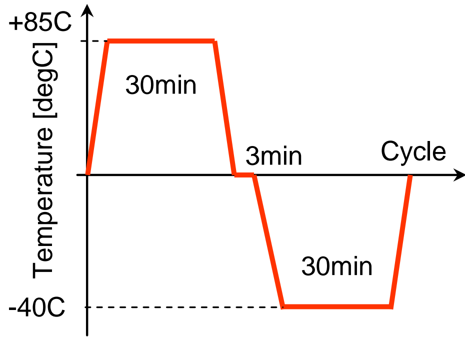
M46 maintain almost same level of joint strength during thermal cycle test even though 0.3Ag based.

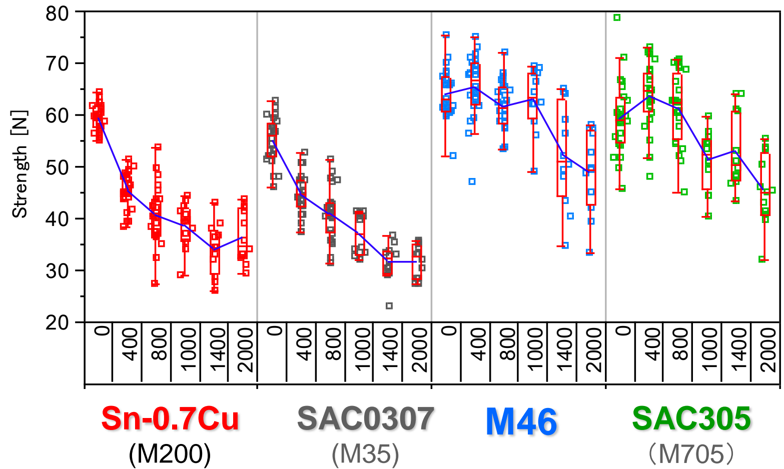


Able to reduce material cost without deterioration of long term products life

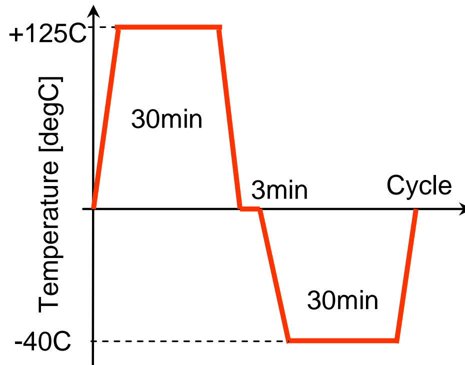
Test device: 3216chip resistor
Shear test speed: 6mm/s

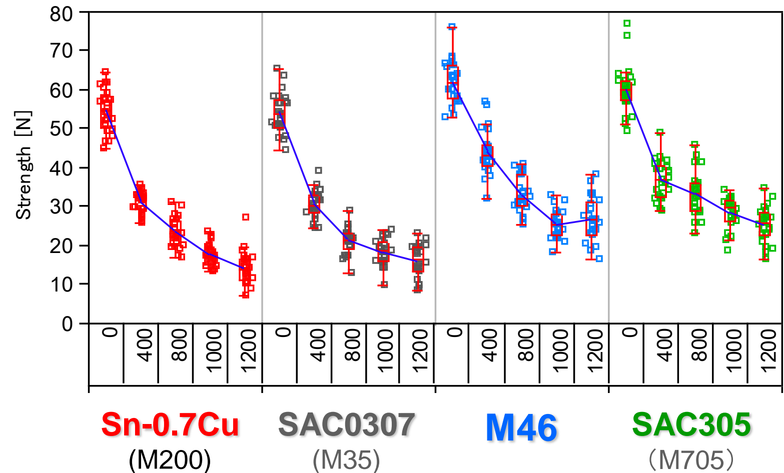
[TCT condition: -40~+85℃ Keep time: 30min]





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



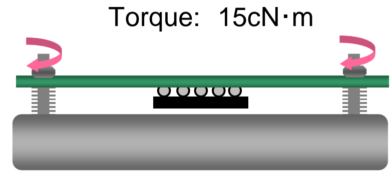


Reliability of solder joint in Drop test

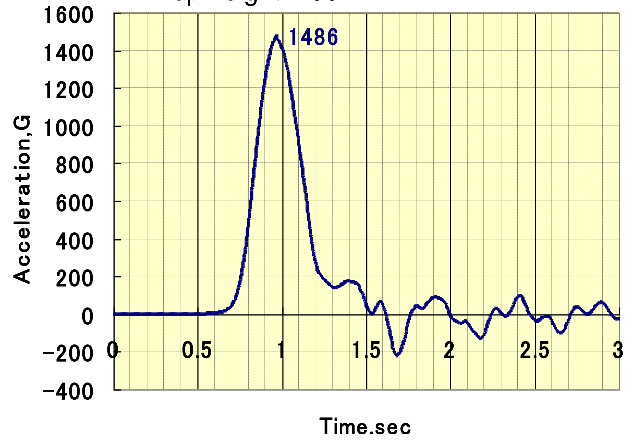
Test condition:
Test device: 12x12mm BGA
Electrode finish: ① Electrolytic Ni/Au
② Cu-OSP
Sphere: SAC305 (M705)

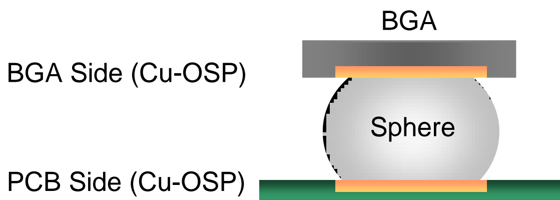
PCB: 30x120x0.8t mm
Surface finish: Cu-OSP (NSMD)

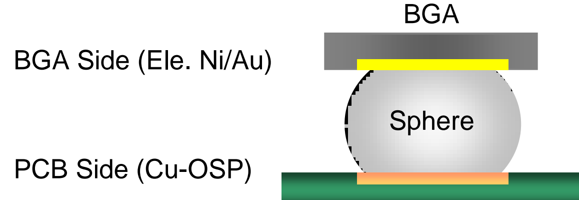
Solder alloy of SMT solder paste:
1. SAC305 (M705)
2. M40
3. M46

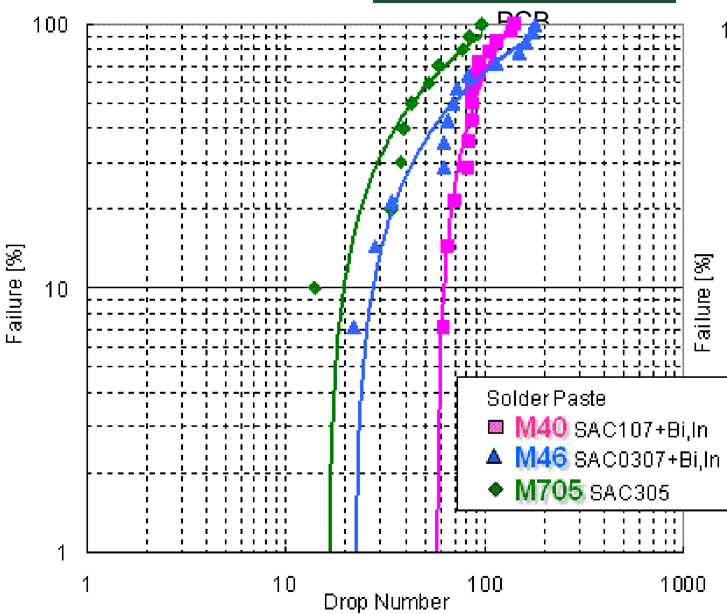


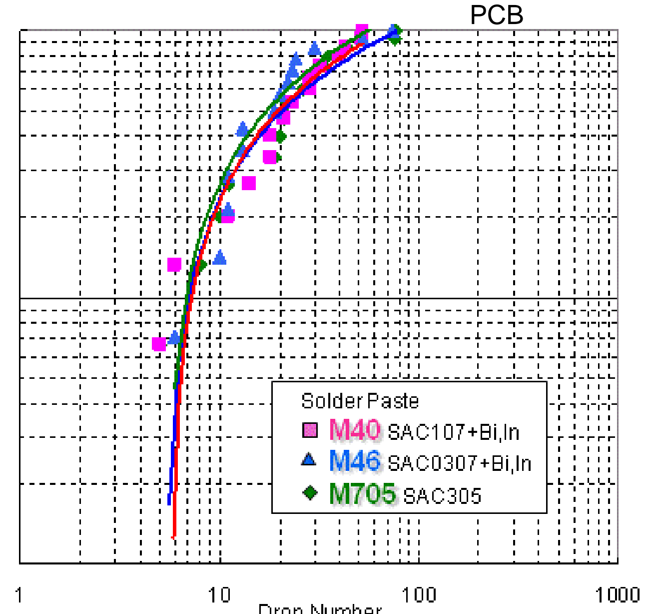
Maximum acceleration: around 1500G
Drop height: 450mm







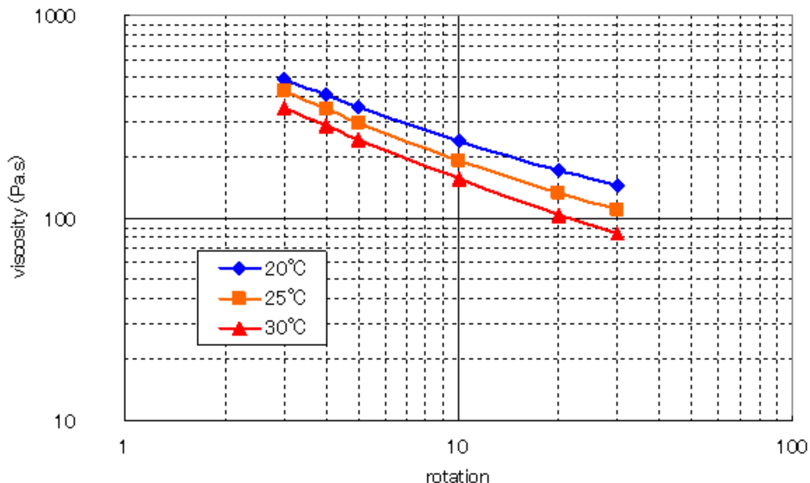




M46, low silver solder paste do not bring about the negative impact on BGA drop reliabilities compared to the SAC305 solder paste.
(Drop reliability would be generally controlled by the combination of sphere composition & electrode finish rather than SMT paste.)

Viscosity with temperature

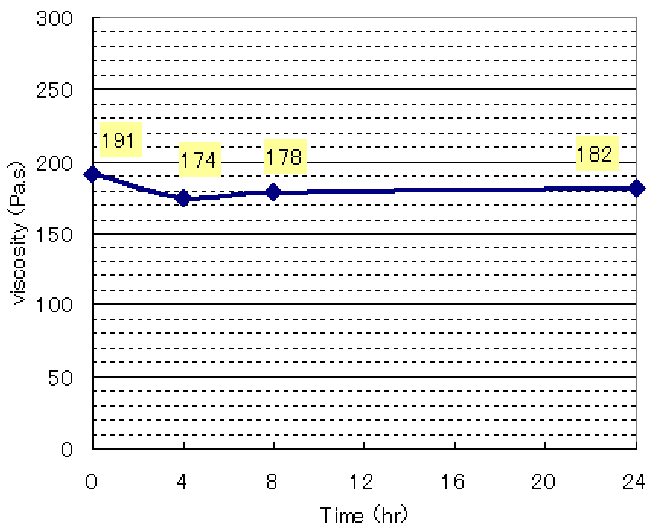
Viscometer: Malcom PCU
Rotate speed: 10rpm
Temperature: 20, 25、30℃



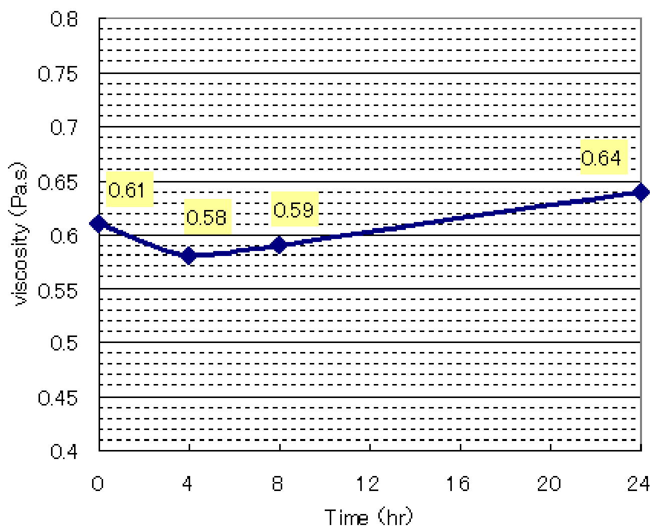
Viscosity & Thixotropic Index change with continuous printing

Squeezing tact: 30sec/Shot
Test environment: 25℃50%RH

[Viscosity change]



[T.I change]



Intermittent Printing properties

Volume(%)
120
110
100
90
80
70
60
50
40
30
20
10
0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Std Dev
20
16
12
8
4
0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

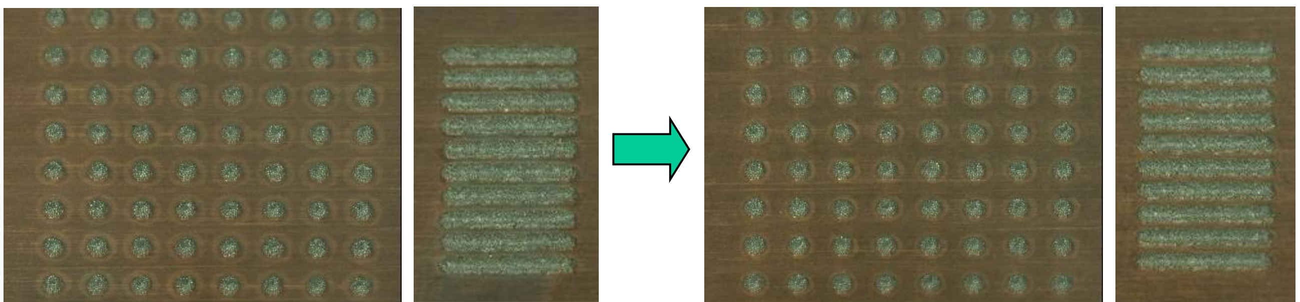
[0.3mm Circle pattern]
[0.4mmPitch 0.2mm Width Slit]

Sheet No within Component

: Pose

Test condition:
Stencil: SUS Laser cut / 5milt
Squeegee: Metal
Angle: 60°
Speed: 100mm/s
Pressure: 0.20N/mm
Separation speed: 5.0mm/s(Fixed mode)
Environment: 25℃50%RH
Pose time 1hr [after 11th sheets]

0.3mm Circle pattern (11th sheet) | 0.4mm Pitch Slit (11th sheet) | 0.3mm Circle pattern (12th sheet) | 0.4mm Pitch Slit (12th sheet)



Printing properties

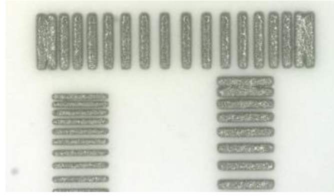
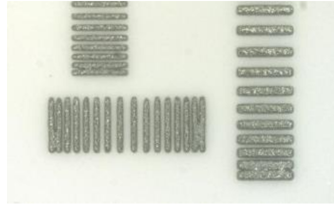
- Excellent print consistency for a broad range of aperture size.

Cold slump & Hot Slump

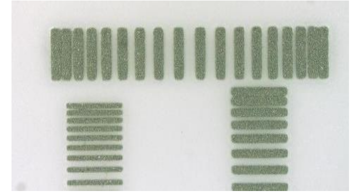
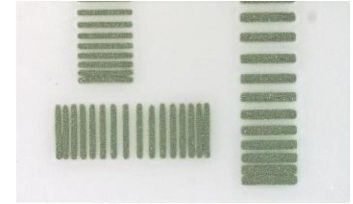
Procedure: IPC-A-20
Thickness: 5mil
Temp & time in hot slump test:
150℃x 3min

	COLD		HOT	
	Hor.	Vert.	Hor.	Vert.
0.20 x 2.03	0.10	0.10	0.125	0.10
0.33 x 2.03	0.15	0.10	0.15	0.10

[mm]

Cold slump

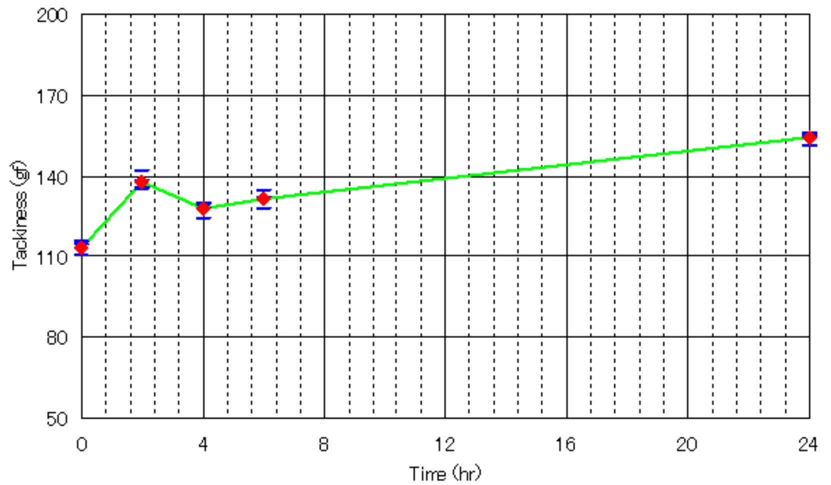



Hot slump
3min@150℃

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℃50%RH

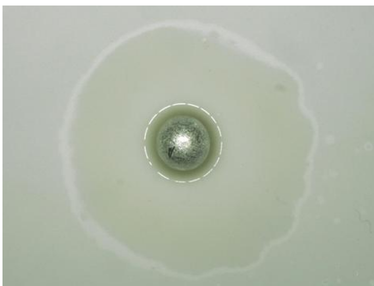
Initial tack force: over 110gf
Keep time above 100gf : over 24h



Solder ball test

Procedure: JIS Z 3284
Heating: 274℃ solder bath
Thickness: 200um
Environment: 25℃50%RH

Initial



Rank 1

8h after print

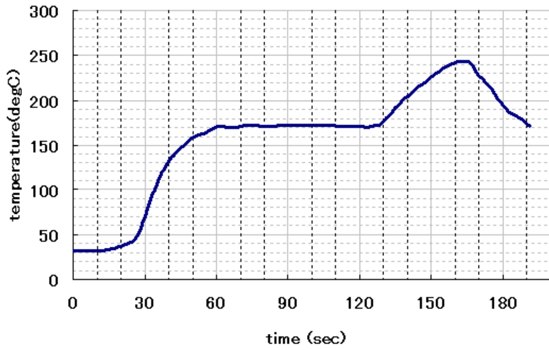
Rank 1

24h after print

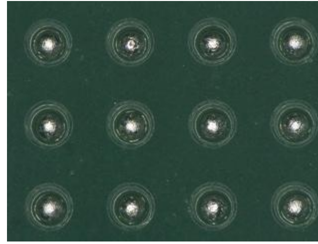
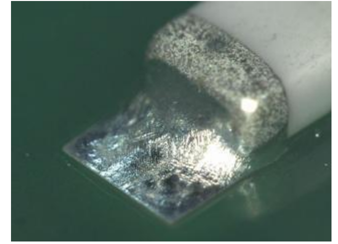
Rank 1~2

Solderability compared to previous SAC305 solder paste

Pad finish: Cu-OSP
Device: Chip capacitor (Sn Plate)
Stencil thickness: 150um
Reflow atmosphere: AIR
Reflow profile: Below
Peak temp: 249 degC

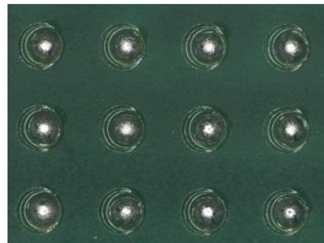
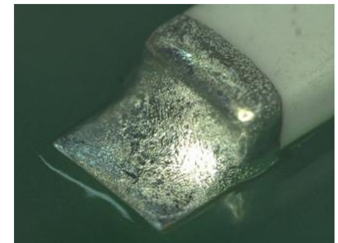


Previous SAC305 solder paste

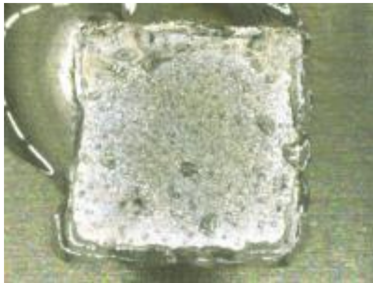
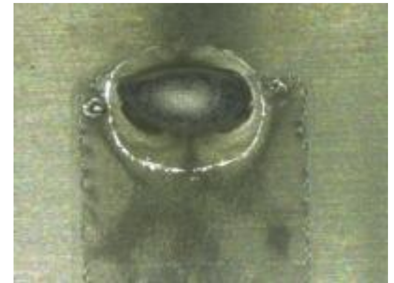
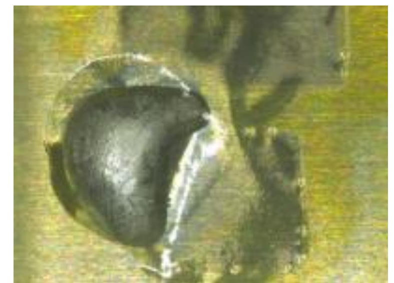



Φ:0.25mm

LS720HF

Φ:0.25mm

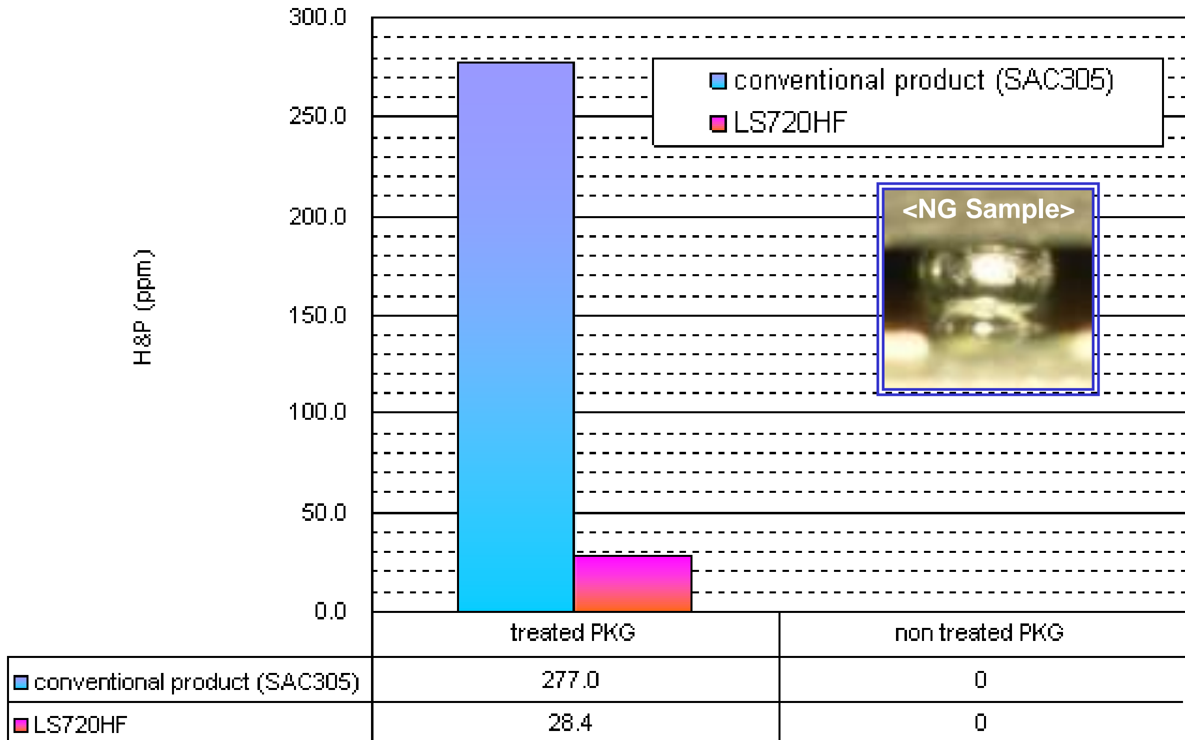
	LS720HF	Previous SAC305 solder paste	Non wetting [NG sample]
Ni Silver [Cu-Ni-Zn]			
Brass [Cu-Zn]			

Large aperture（□5.0mm）

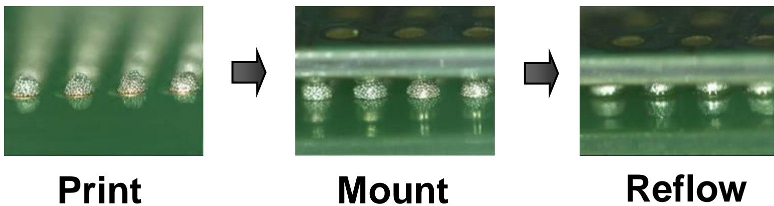
- M46 solder has a Mat surface finish after solidified which will bring about high yield in AOI process.
- M46-LS720HF has good wettability with various metals.

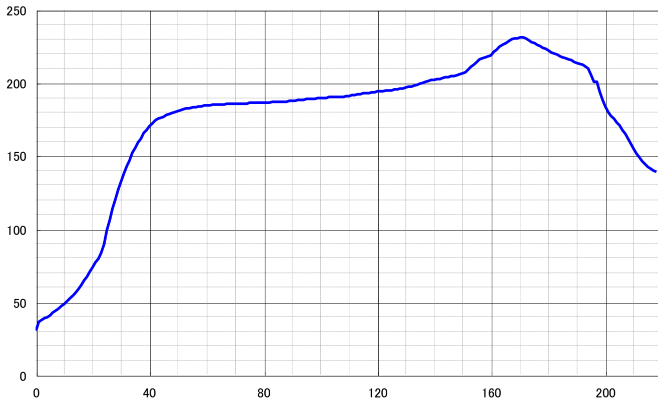
M46-LS720HF Non-fusion of BGA

Count defusion number after separating PKG from PCB by force.
The profile has high pre-heat & short melting time .



	treated PKG	non treated PKG
conventional product (SAC305)	277.0	0
LS720HF	28.4	0





PKG Condition

1. 85degC/85%R.H 72hr
2. Normal

PKG information

352 bump / 1 PKG*4
Bump SAC305 dia:300um
Bump height : about 200um
0.5mm pitch

P.H Temp (degC):	**180-205**
P.H Time (sec):	**90**
Peak Temp (degC):	**231**
Over 225degC (sec):	**14**

- The result of non-fusion test shows that LS720HF is able to reduce non-fusion of BGA when compared to conventional product.

Cooper mirror corrosion

Procedure: JIS Z 3197
Control material: WW rosin 25% IPA solution
Test material: LS720HF flux 25% IPA solution
Temp & Time: 24H@25℃50%RH

Result: Pass
No evidence of mirror breakthrough

M46-LS720HF

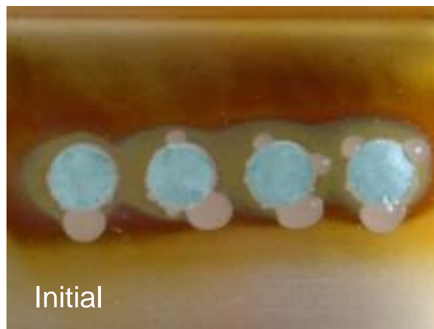
WW rosin solution

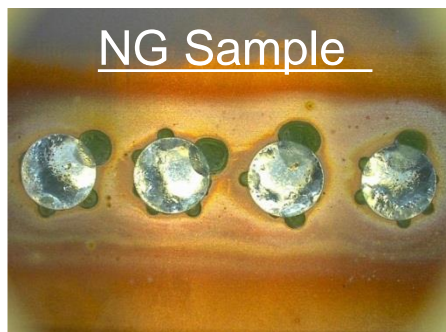
Copper plate corrosion

Procedure: JIS Z 3197
Temp & Time: 72H@40℃90%RH

Result: Pass
No evidence of corrosion

Soldered side | Cover side

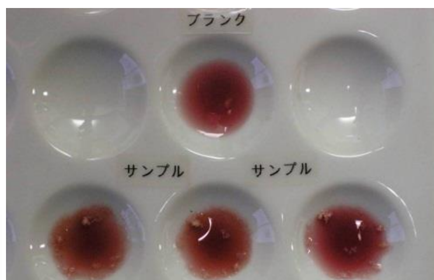




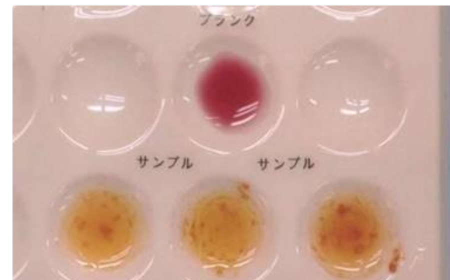
Fluoride spot test

Procedure: JIS Z 3197

Result: Pass
No evidence of color change



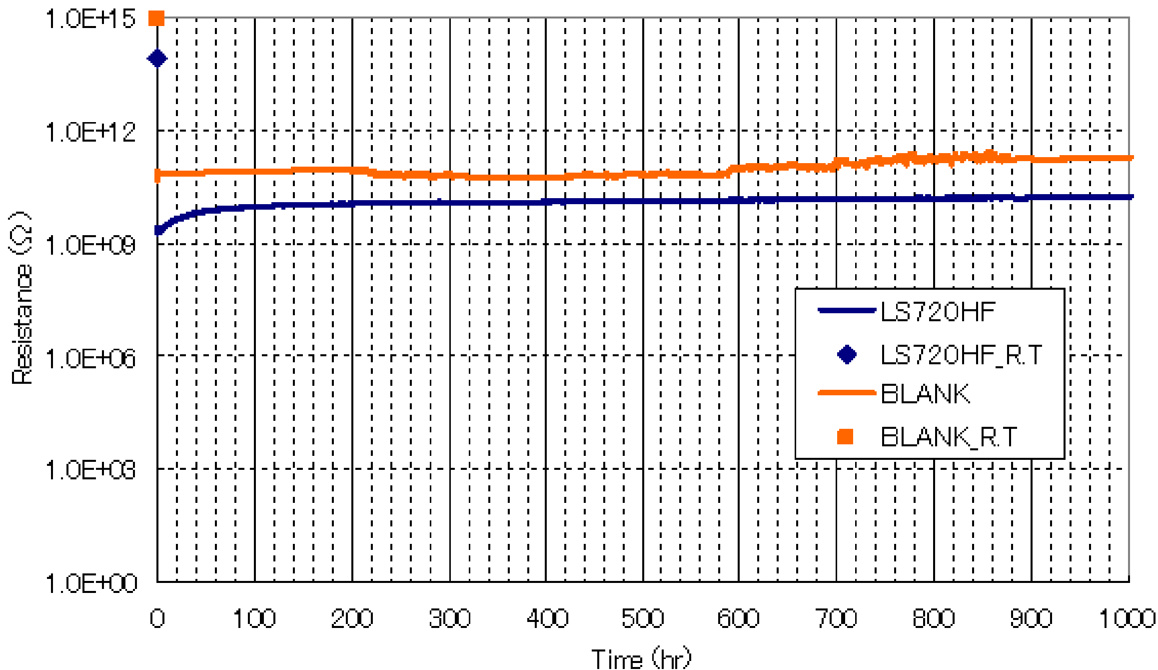
M46-LS720HF



NG Sample (ref)

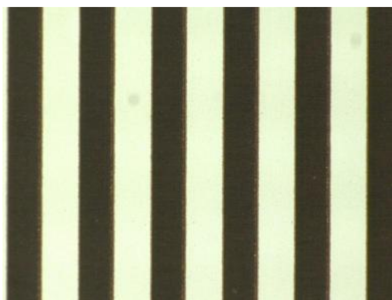
Electrochemical Migration test

Procedure: JIS Z 3284
Test PCB: JIS-2 comb pattern
Test time: 1000h
Print thickness: 0.1mm
Environment: 85℃85%RH
Measuring voltage: DC100V
Applied voltage: DC45V



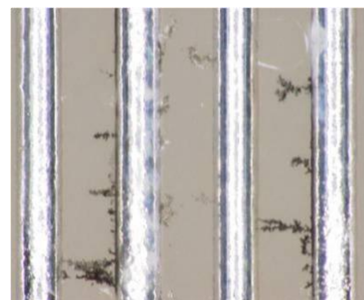
Comb pattern status after testing

Control PCB (Blank)



LS720HF

NG sample (reference)



Result: Pass
No generation of migration

Storage & Handling

Item	Recommended procedure	Remark
Storage	6month at refrigerated 0 ~ 10℃	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℃ 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℃	Allowed to re-storage 1time in validity with putting the lid on firmly.

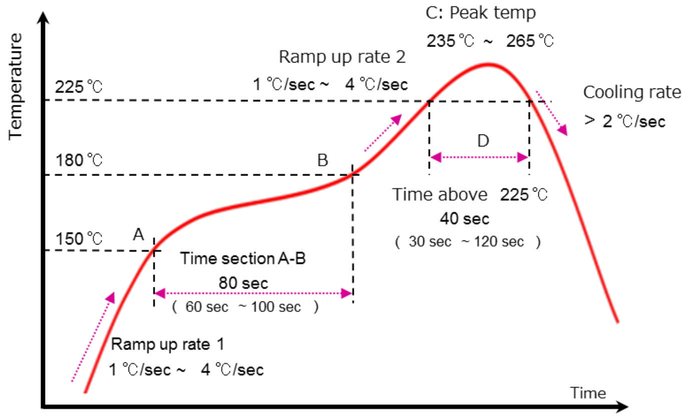
Recommend setting in printing process

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℃ 30 ~ 70%RH	―――

Recommended Reflow profile

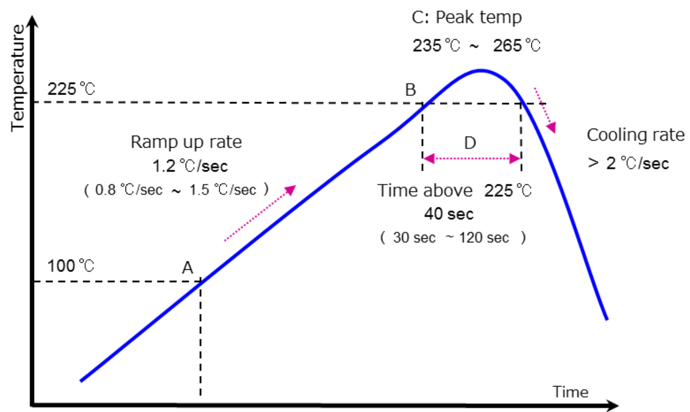
M46-LS720 paste is formulated for using in AIR reflow process. But we also recommend using Nitrogen reflow to obtain higher soldering quality and stability.

Soak Reflow Profile (Standard)



Point		Lower Limit	Recommend	Upper Limit
~ A	Ramp up rate 1	1 ℃/sec	**2 ℃/sec**	4 ℃/sec
A	Soak zone start temp.	140 ℃	**150 ℃**	160 ℃
B	Soak zone end temp.	160 ℃	**180 ℃**	200 ℃
A ~ B	A - B section time	60 sec	**80 sec**	100 sec
B ~ C	Ramp up rate 2	1 ℃/sec	**2 ℃/sec**	4 ℃/sec
C	Peak temperature	235 ℃	**245 ℃**	265 ℃
D	Time above 225 ℃	30 sec	**40 sec**	120 sec
	Cooling rate	2 ℃/sec	**- - -**	- - -

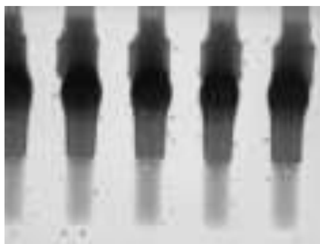
Ramp Reflow Profile (Linear)



Point		Lower Limit	Recommend	Upper Limit
A	Ramp start temp.	- - -	**100 ℃**	- - -
B	Ramp end temp.	- - -	**225 ℃**	- - -
A ~ B	A - B section time (Ramp up rate)	80 sec 1.5 ℃/sec	**1040sec** **1.2 ℃/sec**	160 sec 0.8 ℃/sec
C	Peak temperature	235 ℃	**245 ℃**	265 ℃
D	Time above 225 ℃	30 sec	**40 sec**	120 sec
	Cooling rate	2 ℃/sec	**- - -**	- - -

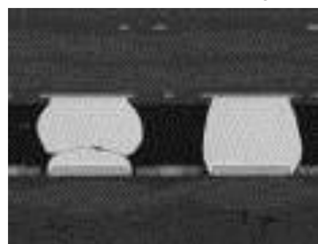
Typical soldering issues related to reflow profile (Ref)

[Sudden ramp up to soak zone]

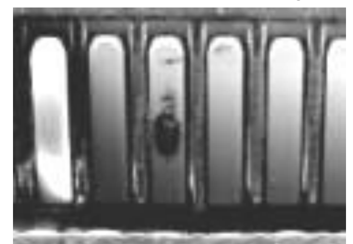

Powder size solder ball

Side ball

[Surplus preheating]


Head in Pillow

[Insufficient preheating]

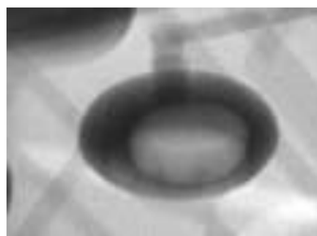

Flux spattering

[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-0.3Ag-0.7Cu-Bi-In-Sb	- - -
Melting temperature	211 ~ 225℃	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 / L0	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	Br > 900ppm Br > 900ppm Br+Cl > 1500ppm	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℃ Sealed condition

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