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HARIMA CHEMICALS, INC.

Concept & Electronic Materials

●Specifications and design are subject to change without notice due to improvements, etc.

Printed in Japan Jan. 2018

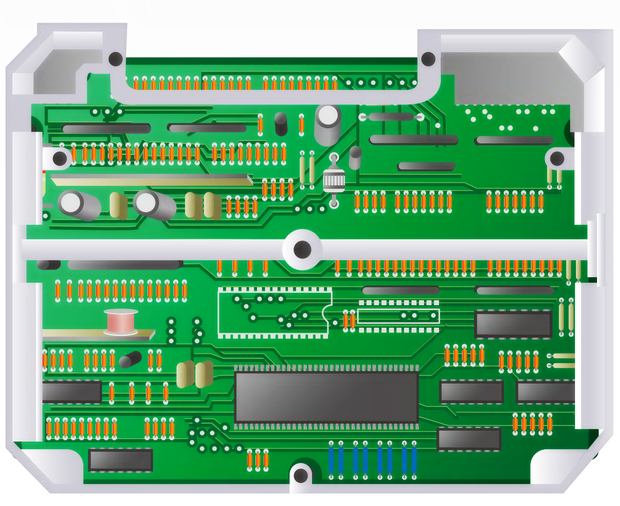
Solution & Contents

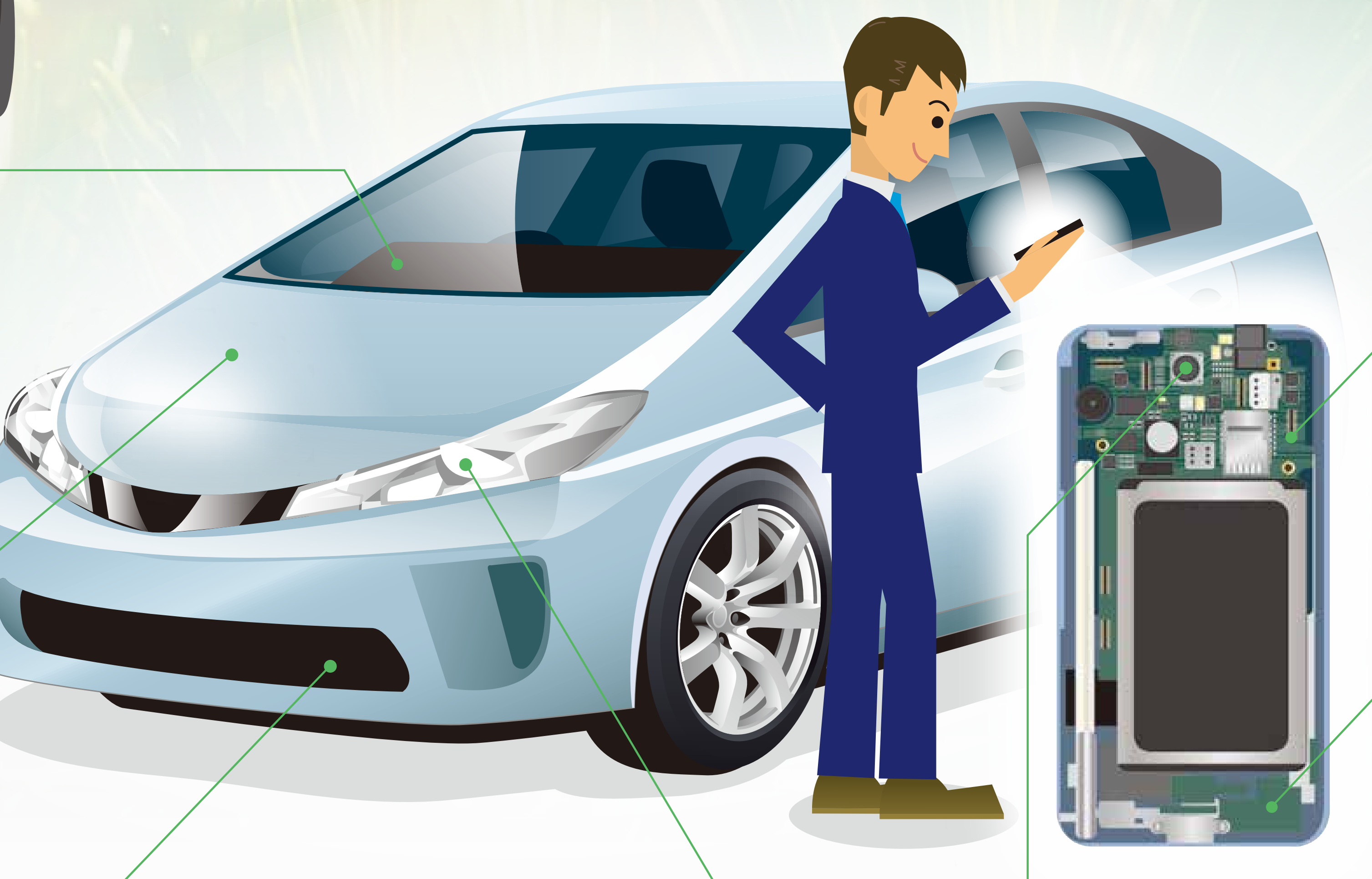
Meter panel

- Solder paste for automobile P10
- Fine pitch printing solder paste for automobile P11
- Copper paste for through-hole P24

Electronic control unit(ECU)
Advanced driver assistance system(ADAS)
Vehicle-mounted camera and censor
Mechanically/electrically-integrated device

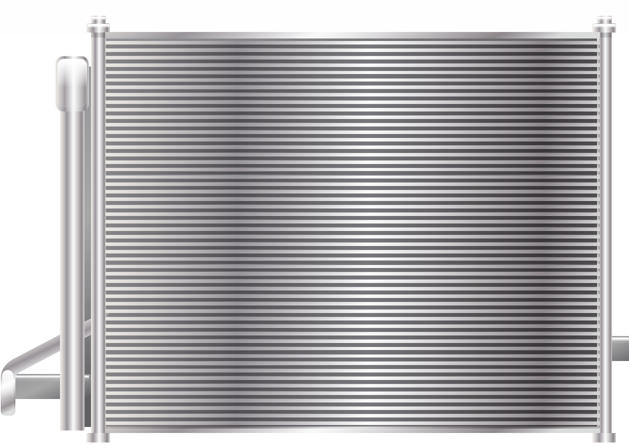
- Highly durable solder paste P8-9
- Solder paste for automobile P10
- Fine pitch printing solder paste for automobile P11
- Residue crack resistance halogen free solder paste P12
- Clean type solder paste P13

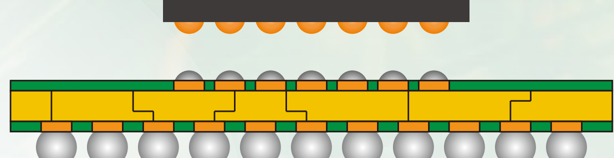




Condenser, evaporator

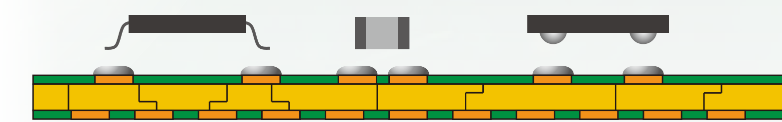
- Brazing Materials P21-23





Semiconductor mounting board

- Solder paste for electronic packaging application P19

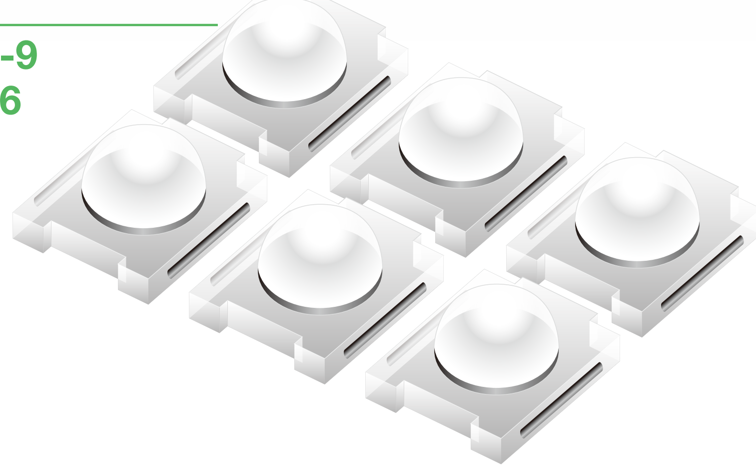


Surface mounting board

- Halogen free solder paste P14-15
- Low-silver lead-free solder paste P16
- 0201 chip compatible solder paste P17
- Sn-3.0Ag-0.5Cu lead-free solder paste P18
- Copper paste for electronic parts electrode P25
- High Adhesive Nano Paste® P27

LED Lamp

- Highly durable solder paste P8-9
- High thermal conductive paste P26



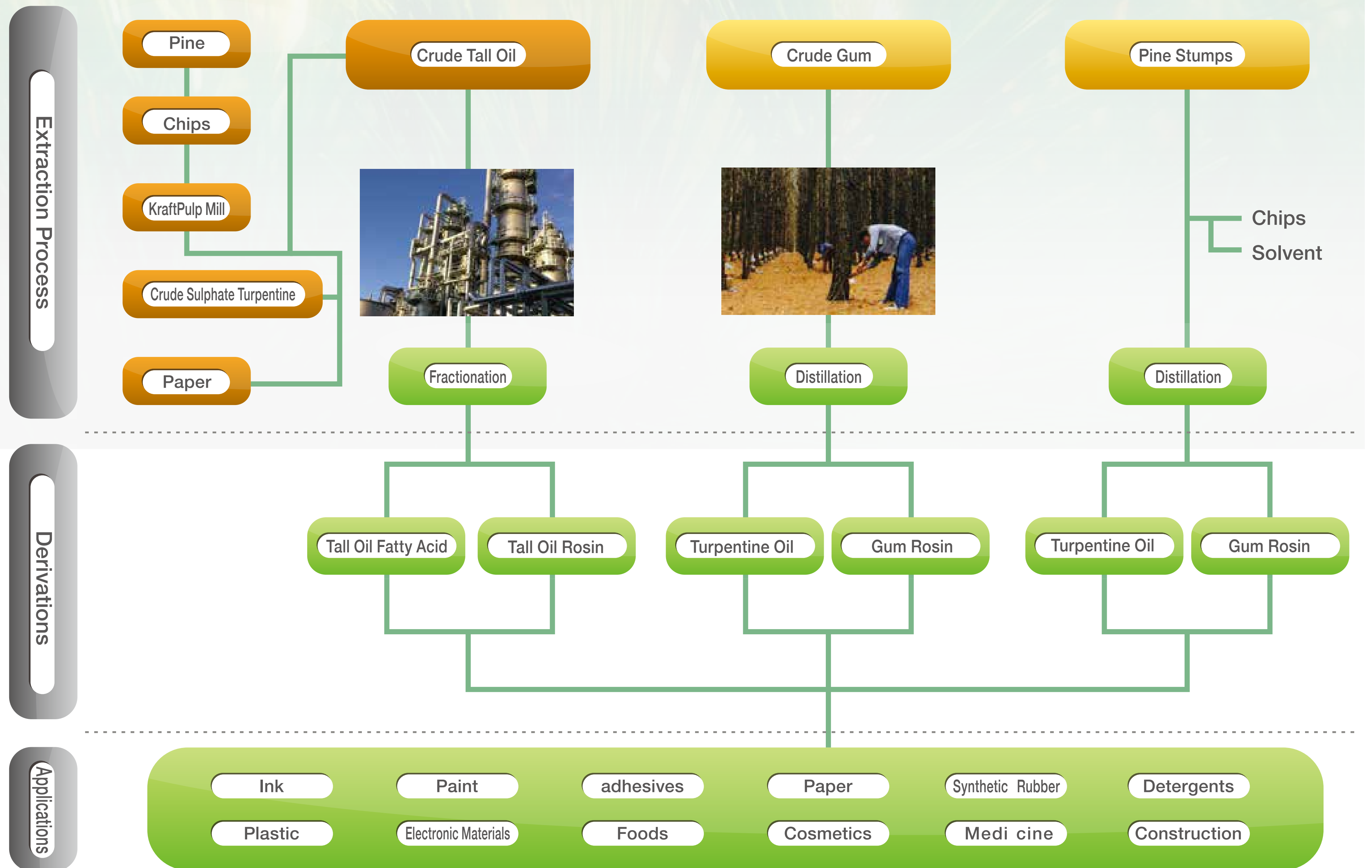
Global Network

Harima Chemicals Group's Network Meeting Global Customer Needs

Clean & High reliability

Lead-edge through Environment Friendly

"Clean and High reliability" is Harima Chemicals' Philosophy to pursue the leading-edge technology in harmony with the natural enviro nment.



Contents

Solder Paste

Highly durable solder paste LSP 8-9
High joint reliability Lead-free solder paste, having excellent joint strength and durability after 3,000 thermal cycles test.

Solder paste for automobile GSP 10
Newly developed 'GSP' achieved all required features of in-car electronics standards, such as high reliability, good ability of soldering and excellent capability of operating.

Fine pitch printing solder paste for automobile CLR 11
'CLR' realized high speed and fine-pitch printability, in addition to the required reliability for automobile.

Residue crack resistance halogen free solder paste HC 12
Residue crack resistance using flexible synthetic resin, having excellent solder wetting without halogen.

Clean type solder paste VHICS 13
Having the long-time use results and superior washing characteristics, solder paste of the washing type with a few voids for junction.

Halogen free solder paste NH 14-15
Environment-friendly halogen free solder paste, reducing voids and achieving highly reliable solder joint.

Low-silver lead-free solder paste HLS 16
Low silver type solder paste which balanced with high reliability and low cost.

0201 chip compatible solder paste FC 17
Newly developed 0201 chip compatible lead-free solder paste contributing to the high functionality and miniaturization of electronic devices and modules.

Sn-3.0Ag-0.5Cu lead-free solder paste HVS 18
Sn-3.0Ag-0.5Cu lead-free solder paste with excellent wetting and printing properties.

Solder paste for electronic packaging application SS,SAC-N,SAC-U 19
Lead-free solder paste for the package inner-bump which is applicable for the super-fine-pitch pattern.

Solder paste product lineup 20
Solder paste products listing various types of solder pastes and alloys to meet customer's remands.

Brazing Materials

Brazing materials and their lineup 21
We propose Brazing products to meet a wide variety of coating method.

Paint flux for roll coating NHP 22
The paint flux provides good adhesiveness and excellent thermal decomposition derived from Harima developed binder.

Anti-corroding clad-less brazing paint ACBP 23
The brazing paint allows clad-less brazing as well as provides corrosion resistance on Al surface after brazing.

Conductive Paste

Copper paste for through-hole CP-800S, CP-1000S 24
Highly-reliable copper paste for through-hole, available for automotive boards.

Copper paste for electronic parts electrode CP-5000D 25
Copper paste applicable for electrode of electronic parts.

High thermal conductive paste NH, SHB 26
These silver pastes have same or higher thermal conductive performance and reliability as solder.

High Adhesive Nano Paste® NPS-L 27
The paste mixed with metal nano-particles can be applied to printed electronics.

LSP Series

~ Highly Durable Lead-free solder paste ~

Due to high functionality and electronic controls of automotive features, highly durable solder joint is a must. Considering all usage conditions, a new lead-free solder alloy (LSP) with superior durability performance is developed.

Characteristics

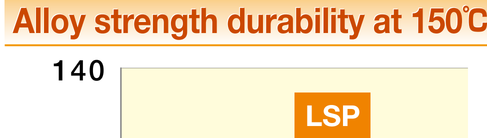
- High joint reliability at harsh installation conditions
- High durability on different boards (glass epoxy/flexible/metal)
- High reliability after soldering, required for automotive applications
- No flux residue crack, and no whisker generation due to complete halogen free

Alloy Composition <Patented>

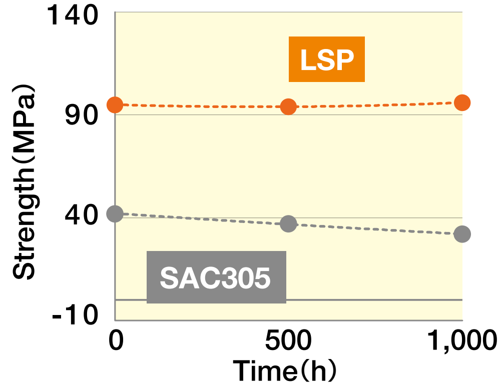
- Two times stronger than SAC305
- No deterioration of strength at 150℃

	LSP	SAC305
Composition	Sn-3.2Ag-0.5Cu-4.0Bi -3.5Sb-Ni+Co	Sn-3.0Ag-0.5Cu
Melting point	223℃	219℃
Strength	**95MPa**	**42MPa**
Elongation	20.4%	33.7%
Young's modulus	51GPa	52GPa

※Alloys other than the above are also available.



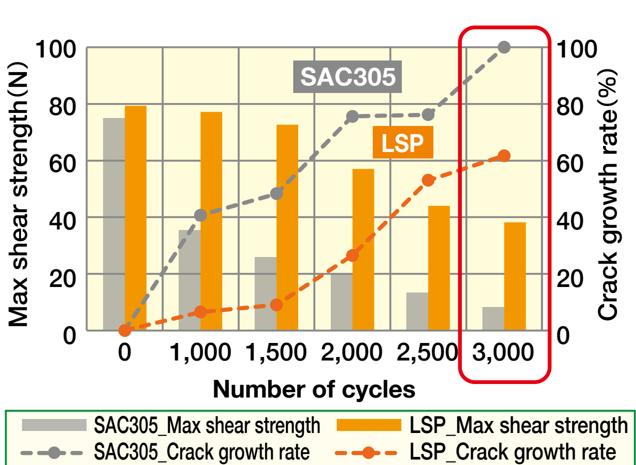
Alloy strength durability at 150℃



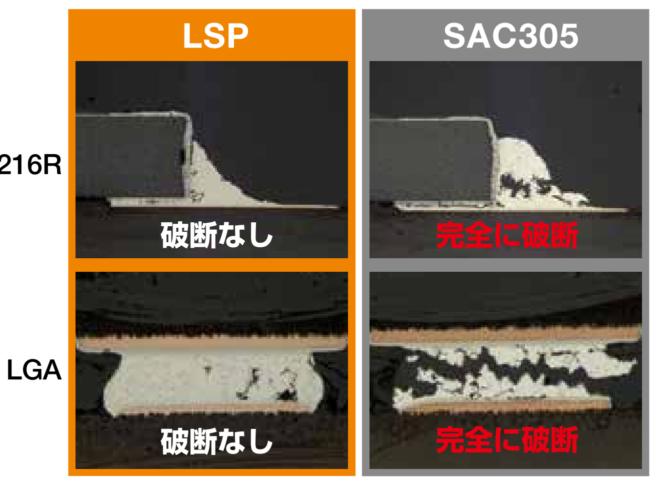
Joint Reliability

- Controls the progress of crack, and maintains high strength after 3,000 cycles
- Effective for solder joints of electronics parts (LGA.QFN) where stress is applied

Crack growth rate and max shear strength

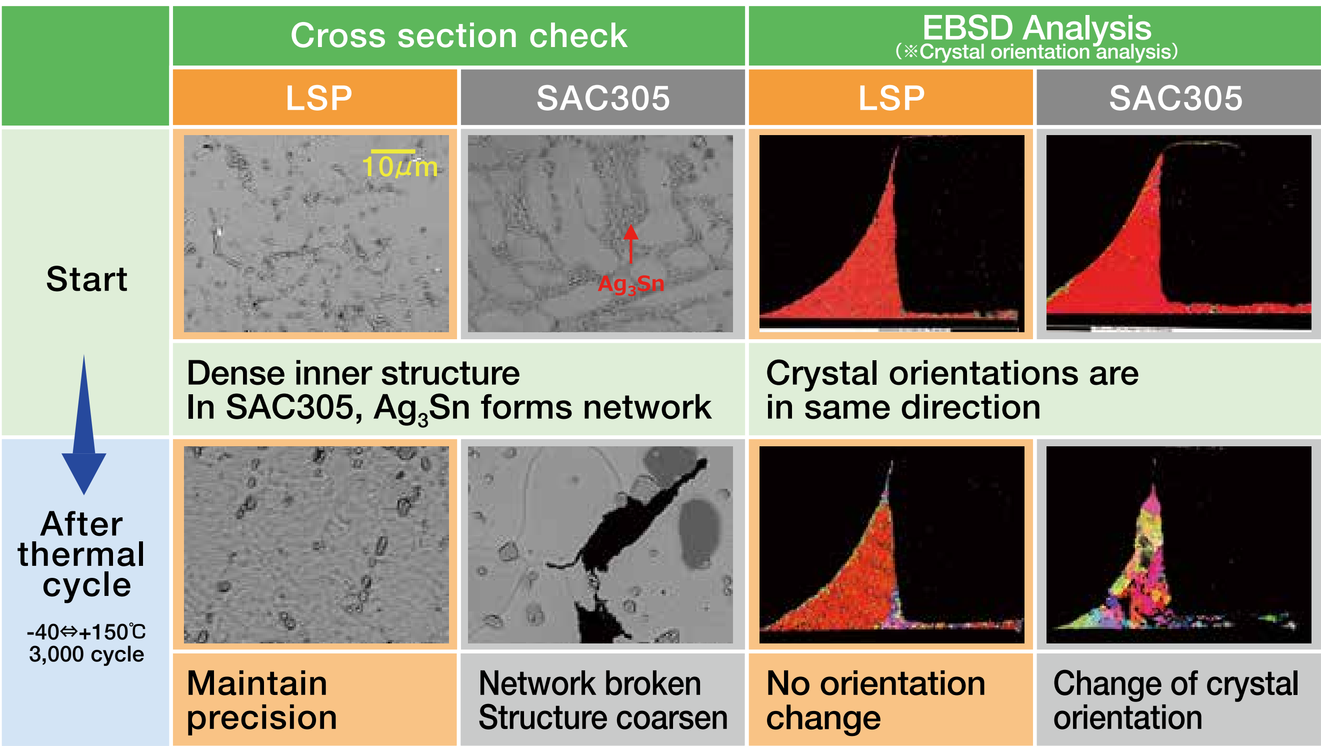


Joint cross section (3,000 cycle)



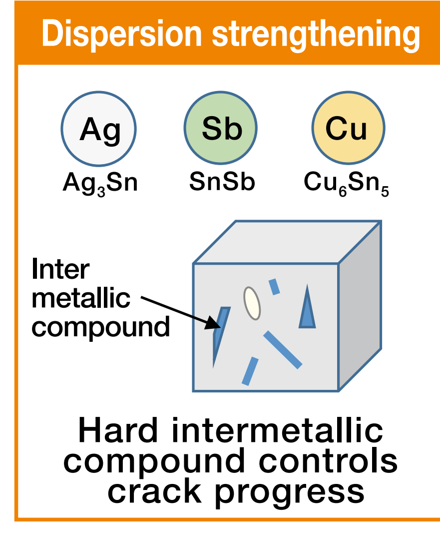
Check cross section

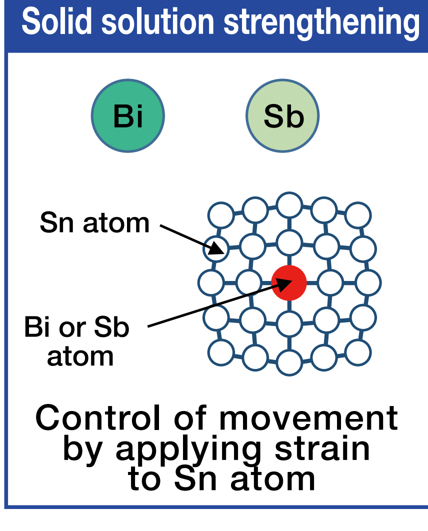
- For LSP, minimal internal structure (intermetallic compound) change
  ▶Maintains strength, prevents crack growth and progress
- For SAC305, coarser internal structure and crystal orientation change
  ▶Strength deterioration, influences crack generation and progress

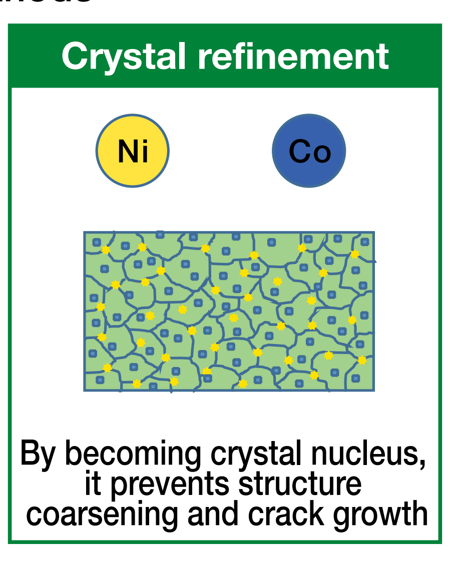


Durability improvement mechanism

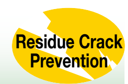
- Realize high durability with 3 strengthening methods







GSP ~ Automotive Standard Solder Paste ~



GSP was developed in collaboration with Toyota, Denso and Denso Ten (Fujitsu Ten). For automotive applications, GSP has excellent electrical and mechanical reliability,even under very severe operating conditions.

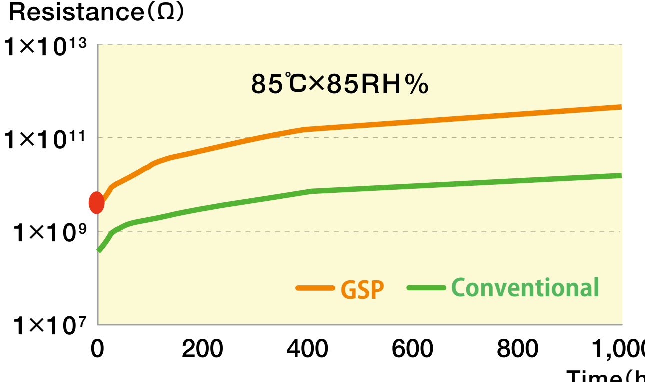
Characteristics

- High insulation resistance value (> 10 (E + 9) Ω) from start to 2,000 hours
- Resistance to flux residue crack (-40⇔+125℃､2,000cycle)
- Stable printing and solderability even after long time continuous printing
- Low solder ball generation even after long time continuous printing

Reliability

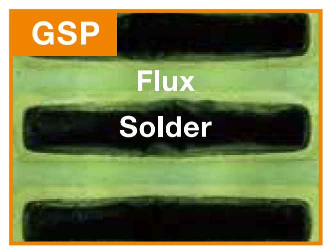
Insulation Resistance Value

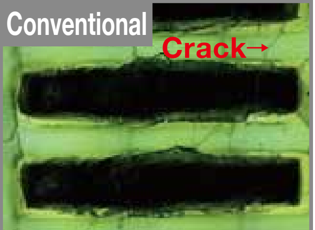
- Maintain high insulation resistance from start



Resistance to residue crack(after 2,000)

- No crack flux residue





Evaluation Condition

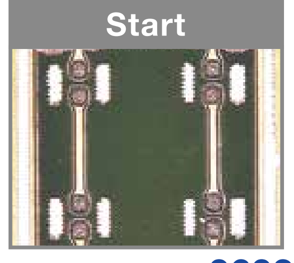
- Cycle Condition :-40⇔+125℃ 30 min
- Observation point :0.5mm Pitch QFP

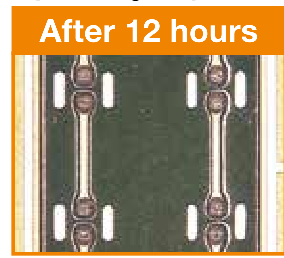
Observe by lighting from the back of the board

Stability over long time usage

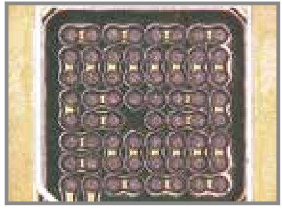
Continuous printing

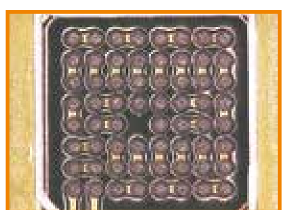
- Stable printing after prolonged period





0603 chip

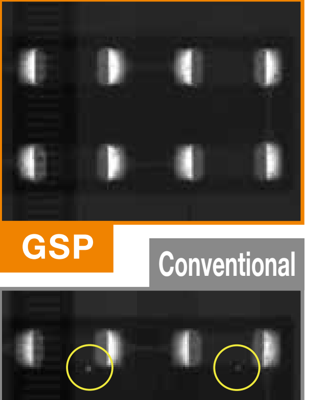


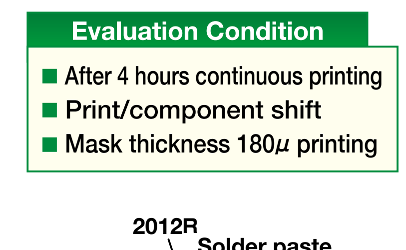


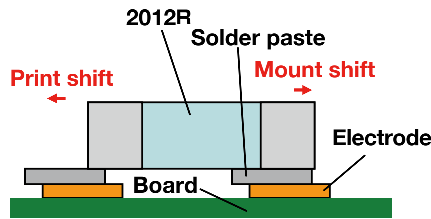
0.5 mm Pitch CSP

Solder ball(after continuous printing)

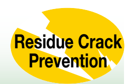
- Low solder ball even after continuous printing







CLR® ~ Fine pitch printing solder paste ~



CLR® has excellent printability。In order to increase joint reliability, even with thicker stencil, enough solder paste can be printed for fine pitch.

Characteristics

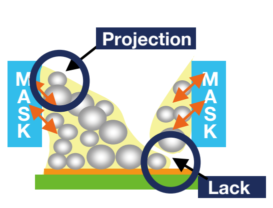
- To improve printability, new synthetic resin with enhanced water repellency is developed
- With mask thickness 150μm, stable printing is possible for 0.4mmQFP & 0.5mmBGA
- Excellent printability is achieved even at high speed printing (~100mm/sec)
- Resistance to flux residue crack (-40⇔125℃、2,000 cycle)

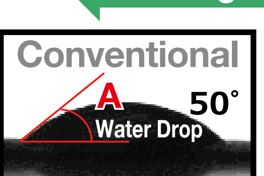
Printability

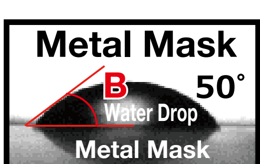
Mechanism for improved printing performance

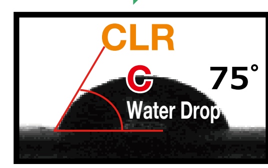
- Less friction with metal mask opening, and as a result, fine pitch printing improved
- Adding water repellant material improved electrical reliability

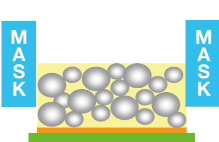
Strong　Metal mask　Weak







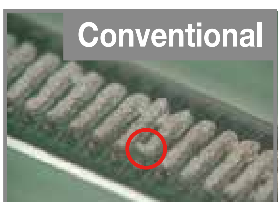




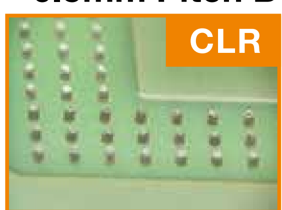
Printing (Mask thickness :150μm)

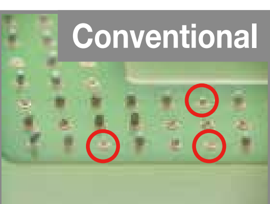
- 0.4mmQFP・0.5mmBGA mounting is possible with 150μm mask

0.4mm Pitch QFP



0.5mm Pitch BGA

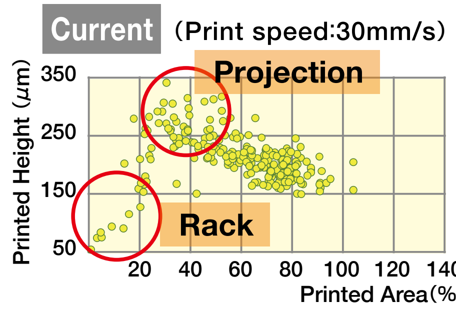




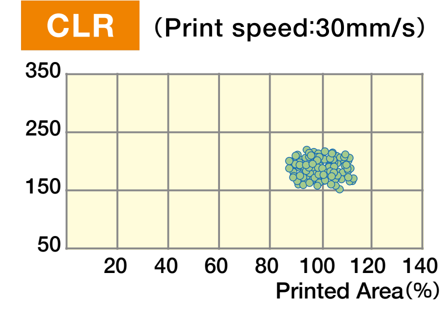
High Speed Printing (Mask thickness：150μm　Openting：Φ0.275mm)

- Maintain excellent printing at high speed printing (100mm/sec)

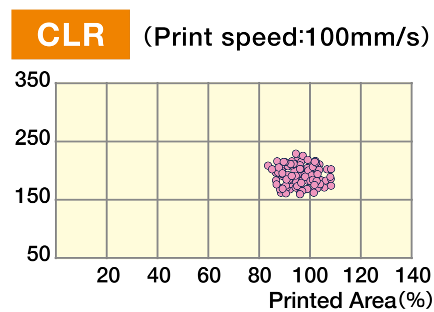
Current (Print speed:30mm/s)



CLR (Print speed:30mm/s)



CLR (Print speed:100mm/s)



~ Residue crack resistance~ Halogen free solder paste

Residue Crack Prevention | Halogen Free

Residue crack resistance perfect halogen free solder paste

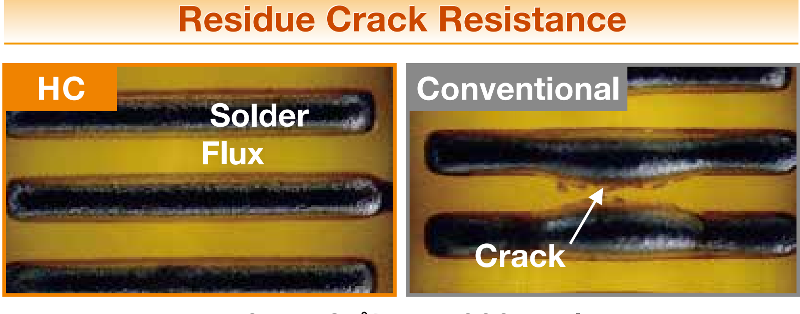
Characteristics

- Prevents residue crack by using flexible synthetic resin
- Ensures superior electrical reliability, high insulation resistance from start
- Controls whisker generation by using perfect halogen free flux

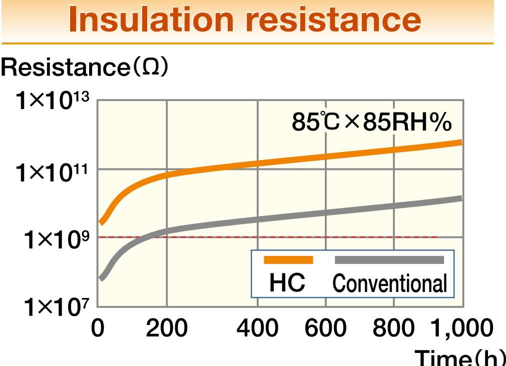
Reliability

- High crack resistance after thermal cycle
- High insulation resistance from start, and offers superior electrical reliability

Residue Crack Resistance



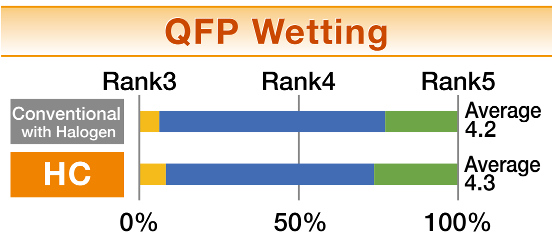
Insulation resistance

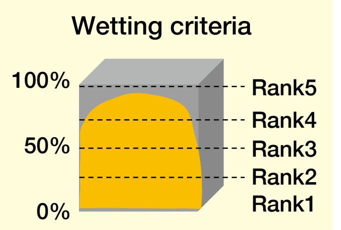


Wetting Characteristics

- Excellent wetting without halogen

QFP Wetting

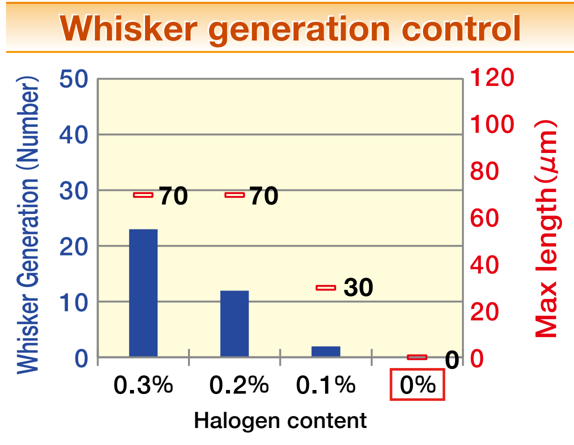




Whisker prevention

- Controls whisker generation by using halogen free flux

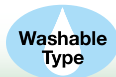
Whisker generation control



Due to high density component mounting space between components are getting narrower, and whisker generation may cause short circuit.

VHICS

~ Clean type solder paste ~



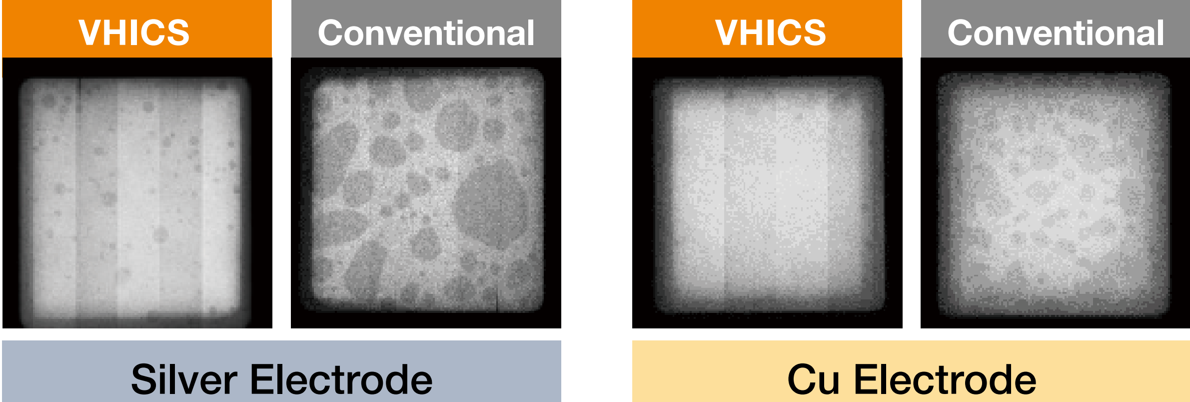
Low void generation of heatsink heat radiation bottom electrode, has superior residue cleaning characteristics

Characteristics

- Regardless of electrode, low void generation of bottom electrode
- No alteration of flux after reflow heating , offers superior cleaning performance
- Controls solder or flux spattering in reflow

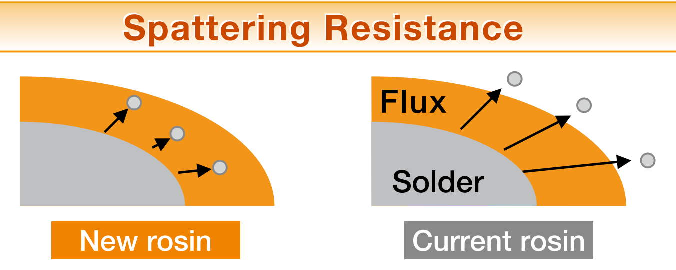
Void

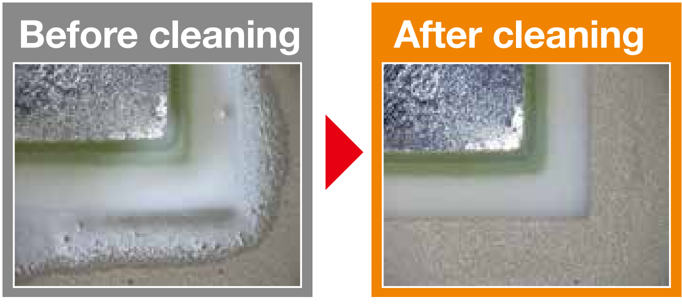
- Void generation was controlled by choosing active agent suitable for electrode



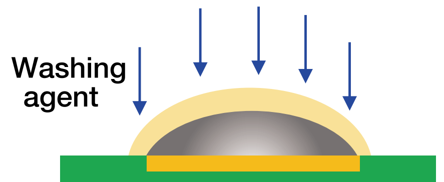
Cleaning・Spattering Characteristics

- Control spattering by using strong adhesion rosin
- Use of newly developed rosin with superior heat resistance and strong adhesion performance



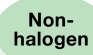


※Cleaning solution, Clean though 750HS (by Kao Corporation)



Use of heat resistance rosin prevents oxidation, provides excellent cleaning performance

NH series ~Halogen free solder paste~



Does not contain environment polluting halogen such as Chlorine or Bromine, this is Sn-3.0Ag-0.5Cu halogen free solder paste.

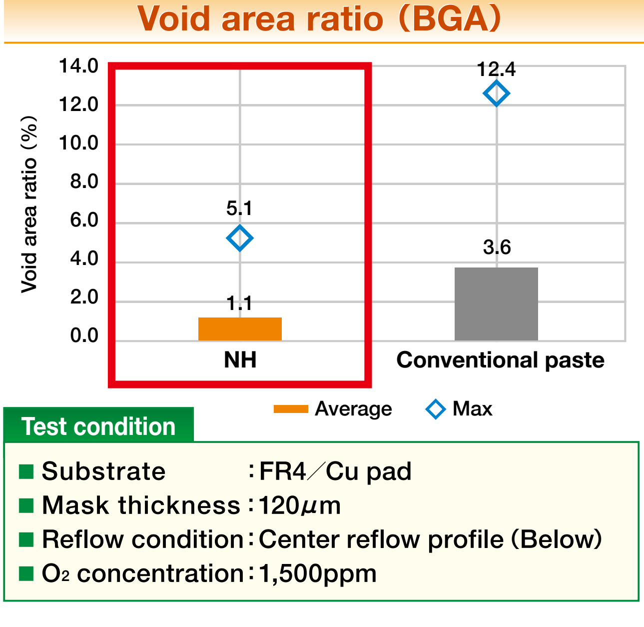
Characteristics

- Reduces voids, realizes highly reliable solder joint
- Applicable to wide range of reflow profiles, and products

Void performance

- Low void generation

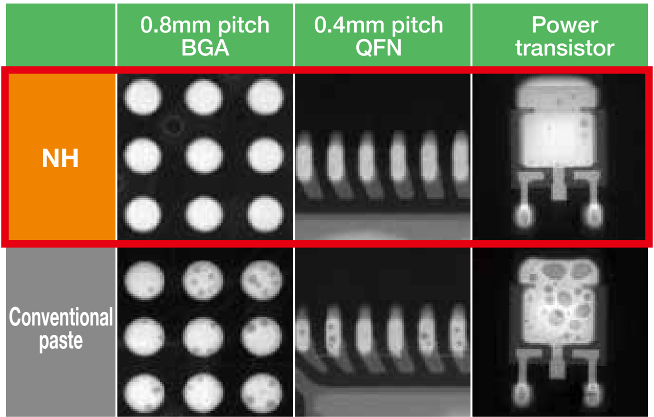
Void area ratio (BGA)



Test condition

- Substrate: FR4/Cu pad
- Mask thickness: 120µm
- Reflow condition: Center reflow profile (Below)
- O_2 concentration: 1,500ppm

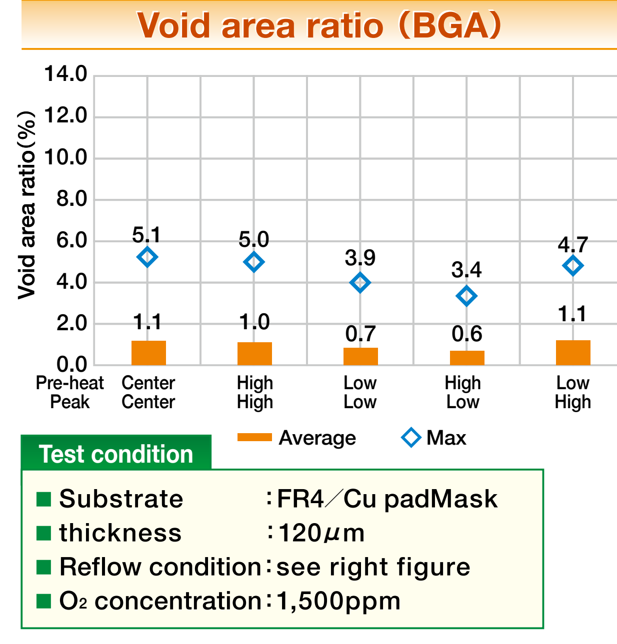
Void results of each components (X-ray)



Void performance for different reflow profiles

- Applicable to wide range of profiles

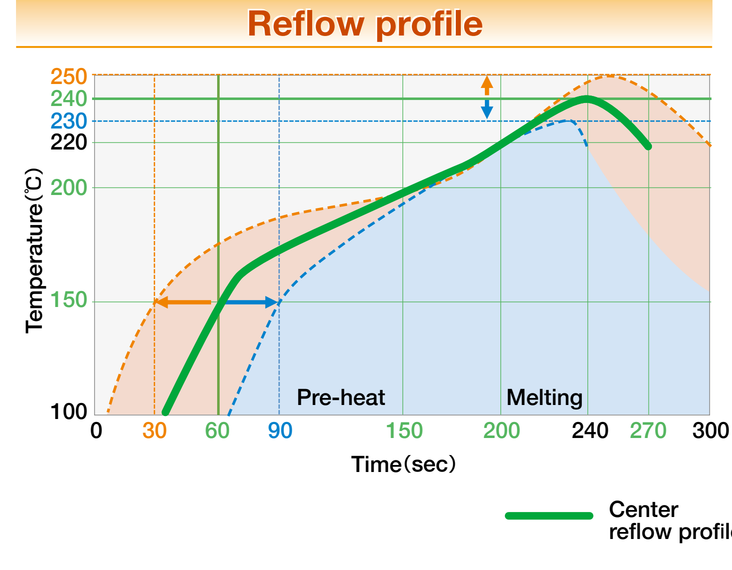
Void area ratio (BGA)



Test condition

- Substrate: FR4/Cu padMask
- thickness: 120µm
- Reflow condition: see right figure
- O_2 concentration: 1,500ppm

Reflow profile



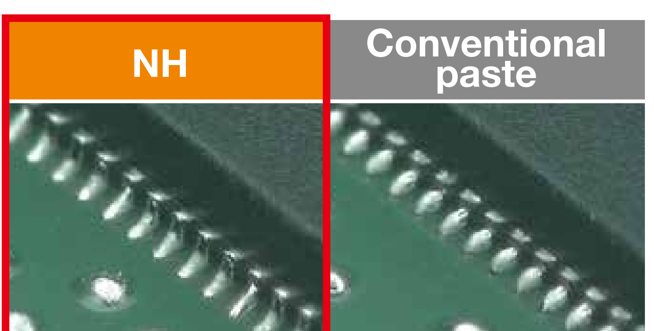
Wettability

●Good wettability

ϕ250μm pad

NH	Conventional paste

0.4mm pitch QFN



Reliability

●High insulation resistance and corrosion resistant

Surface insulation resistance

85℃85%, 50V applying (Measure 100V)

Resistance (Ω)

1×10^{13}

1×10^{11}

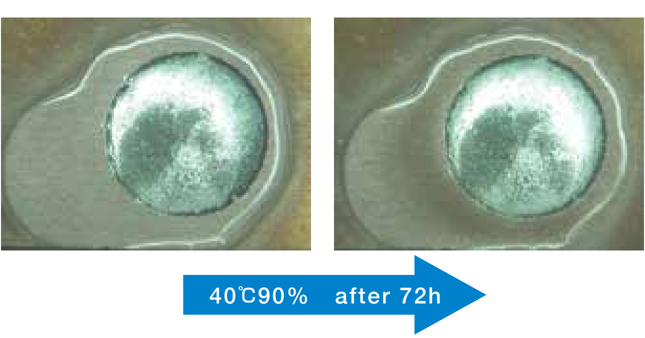
1×10^{9}

1×10^{7}

0 200 400 600 800 1,000

Time (h)

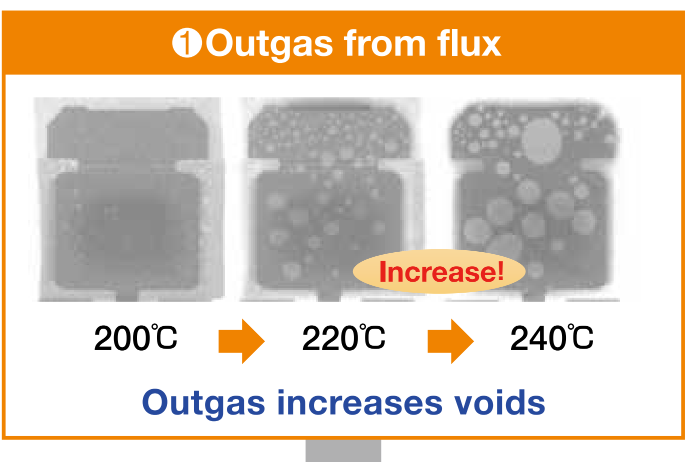
Copper board corrosion

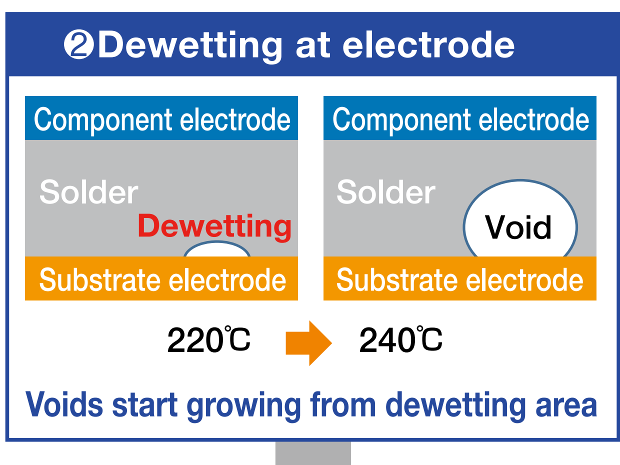


40℃90% after 72h

Void improvement mechanism

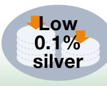
●Void formation factors





NH Achieve low void by reducing outgas and improving wettability

HLS series ~Low-silver lead-free solder paste~



Developed highly reliable and low cost low silver alloy solder paste with excellent thermal fatigue and drop impact resistance properties

Characteristics

- Realize higher joint strength and drop impact resistance with low silver alloys than SAC305
- Applicable to various reflow profiles of SAC305

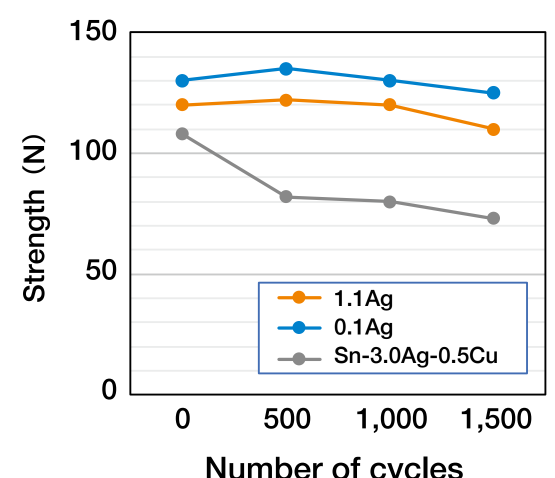
Alloy composition <Patented>

	Low 1.1% silver type	Low 0.1% silver type	SAC305
Composition	Sn-1.1Ag-0.7Cu-1.7Bi + α	Sn-0.1Ag-0.7Cu-2.0Bi +β	Sn-3.0Ag-0.5Cu
Melting point	223℃	225℃	219℃
Strength	64MPa	71MPa	42MPa
Elongation	35.2%	26.2%	33.7%

Joint reliability

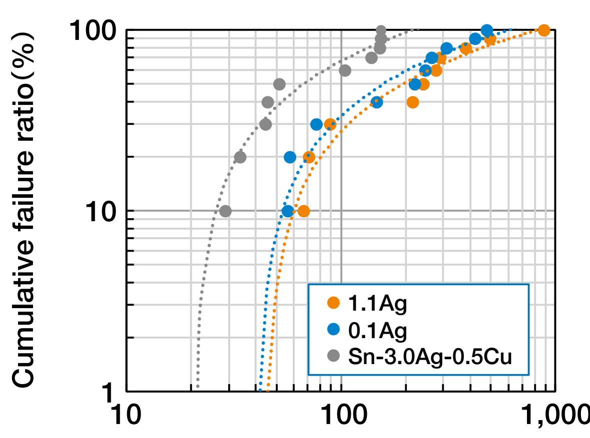
- Excellent joint strength and drop impact resistance

Joint strength (Thermal cycle test)



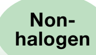
Test condition
- Substrate : FR4／Cu pad
- Mask thickness : 150μm
- Component : 3216R
- Cycle condition : -40⇔125℃ (30min. each)

Drop impact resistance



Test condition
- Substrate : FR4／Cu pad
- Mask thickness : 120μm
- Component : 0.5mm pitch LGA
- Drop impact condition : JEDEC 1,500G

FC series ~0201 chip compatible solder paste~

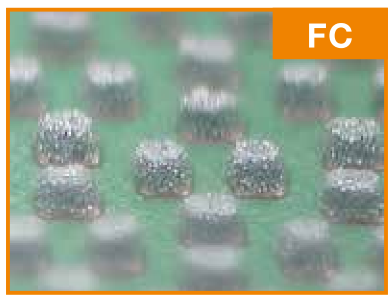


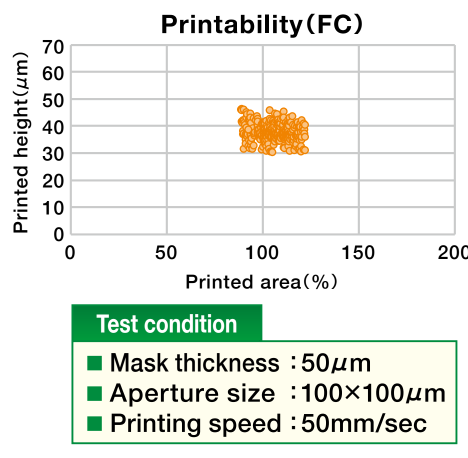
Developed 0201 chip compatible solder paste contributing to the high functionality and miniaturization of electronic devices and modules.

Characteristics

- Excellent printing at small aperture, and good wetting characteristics
- Small change of viscosity after continuous printing, can be used for a long period of time

Printability

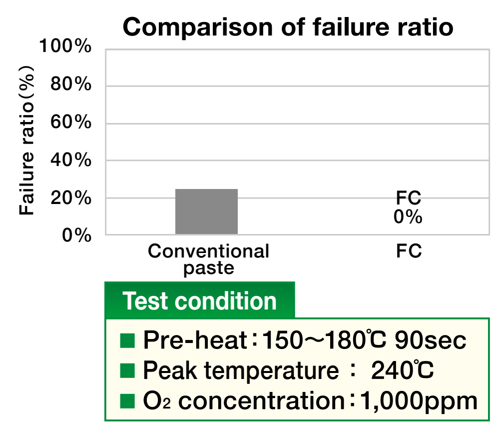




Test condition

- Mask thickness : 50μm
- Aperture size : 100×100μm
- Printing speed : 50mm/sec

Mount wettability

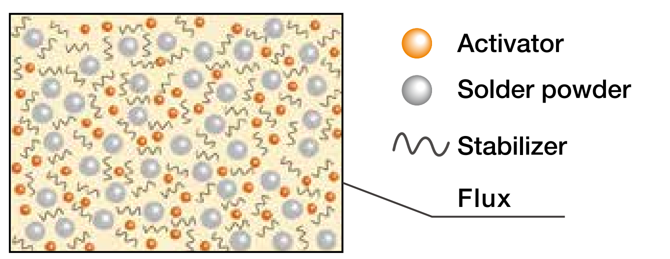


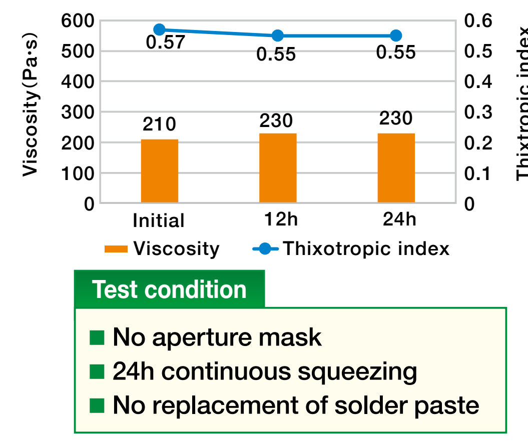
Test condition

- Pre-heat : 150~180℃ 90sec
- Peak temperature : 240℃
- O_2 concentration : 1,000ppm

Viscosity stability

- Suppress reaction between solder and activator by stable dispersion of flux ingredients
  - ▶Enable long time continuous printing





Test condition

- No aperture mask
- 24h continuous squeezing
- No replacement of solder paste

HVS series ~Sn-3.0Ag-0.5Cu lead-free solder paste~

Sn-3.0Ag-0.5Cu generally better characteristic solder paste, contributing to higher productivity and low cost for commercial production

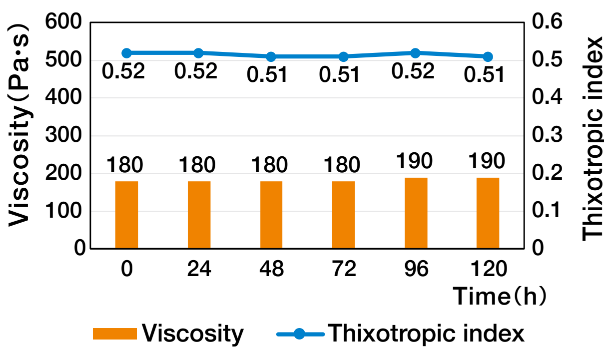
Characteristics

- Realize stable printing and soldering, minimal performance change of paste in operation
- Reduction of waste paste amount by replenishment at continuous usage

Waste paste reduction

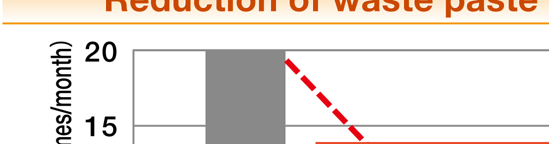
●Small change of viscosity

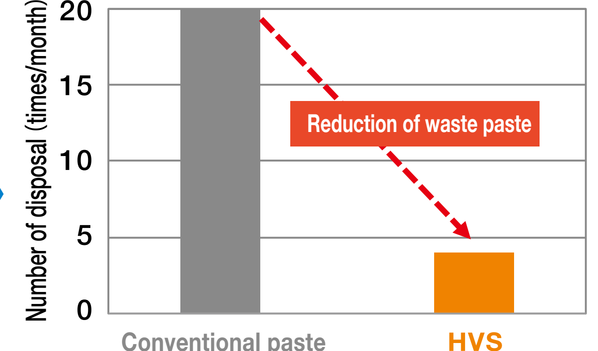
Viscosity change during continuous printing



●Waste reduction to 1/5

Reduction of waste paste





Test condition

- No aperture mask
- 50% of paste replacement, every 12 hours

Printability and wettability

●Stable printing and wetting

	Printability	Wettabilty
ϕ0.25mm Pad		
0.18×1.0mm Pad		

Test condition

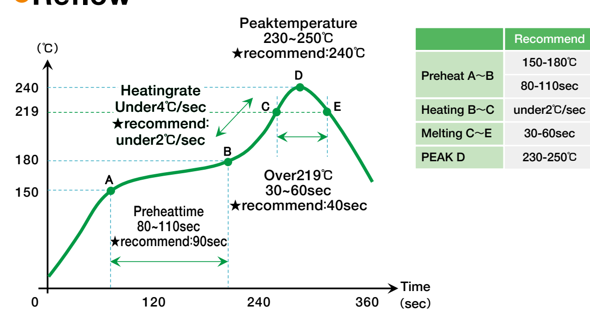
- Mask thickness : 120μm
- O_2 concentration : Air reflow

Recommended condition

●Printing

	Recommend
Squeeze type	Metal, Urethane, Plastic
Printing speed (mm/sec)	30~80
Printing pressure (×10⁻²N)	20~50
Separation speed (mm/sec)	1.0~5.0
Separation mode	Constant speed

●Reflow



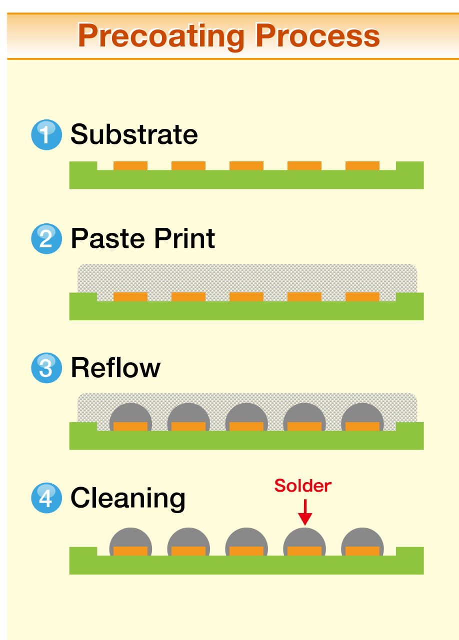
	Recommend
Preheat A~B	150-180℃
	80-110sec
Heating B~C	under2℃/sec
Melting C~E	30-60sec
PEAK D	230-250℃

Super Solder (SS)、SAC-N、SAC-Useries
~Lead-free paste for fine-pitch bump~

Fine-pitch soldering materials for peripheral substrate (Super Solder) and fine-pitch area array substrate(SAC-N, SAC-U series).

Peripheral Substrate / Whole Surface Print Method

Precoating Process

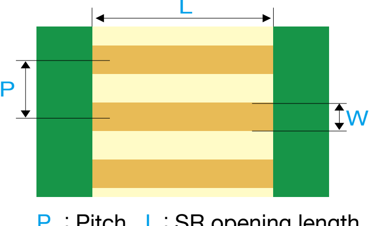


Precoating Examples※

(unit:μm)

Condition	1	2	3	4
Electrode shape	Straight			
Arrangement	In-Line		Staggered	
Pitch, P	60	50	35	30
Length, L	120	80	140	120
Width, W	30	20	35	30
Mean bump height	14	12	14	13
STD	1.4	1.3	1.4	1.3

※) Representative values (not guaranteed)

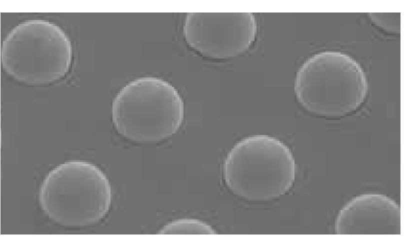


P : Pitch L : SR opening length
W : Pad width

▲ 50 μm-pitch substrate Precoated Solder

Bump Formation : Fine-pitch Capability & Ultra Low-alpha Emission

Solder Bump Formation by SAC-U-330(150μm pitch Substrate)



- Mean Bump Height : 35μm※
- STD : 2

※Representative values (not guaranteed)

Application	Fine-pitch Area Array Bump		Ultra- fine-pitch Area Array Bump	
Product Name	SAC-N-400	SAC-U-600	SAC-N-110	SAC-U-330
Ultra Low α	Non Compliant	Compliant	Non Compliant	Compliant
α Emission Count	high α	< 0.002 cph/cm²	high α	< 0.002 cph/cm²
Alloy Composition	Sn-3.0Ag-0.5Cu		Sn-3.0Ag-0.5Cu	
Melting Point	220 ℃		220 ℃	
Particle Size	5-15 μm		1-10 μm	
Viscosity	280 Pa·s		300 Pa·s	

Solder paste product lineup

Solder paste product lineup

	Product name	Feature	Alloy composition	Powder size (μm)	Viscosity (Pa·s)
Automotive	GSP	Automotive for general purpose	Sn-3.0Ag-0.5Cu	20-38	160
	CLR	Excellent printability	Sn-3.0Ag-0.5Cu	20-38	220
	PS48BR-600-LSP	High durability	Sn-3.2Ag-0.5Cu-4.0Bi-3.5Sb-Ni-Co	20-38	220
	PS31B-600-HC1	Halogen free	Sn-3.0Ag-0.5Cu	20-38	200
	PS31BR-600A-VHICS	Washable and voidless	Sn-3.0Ag-0.5Cu	20-38	200
	PS10B-600A-ANI-1	Tin-lead for general purpose	Sn-37Pb	20-38	200
	PS60B-450A-TR5	Tombstone improved	Sn-36Pb-2Ag	20-38	200
Consumer electrronics	PS31BR-600A-HVS3 PS31BR-700A-HVS3	Lead-free for general purpose	Sn-3.0Ag-0.5Cu	20-38 15-25	180
	PS31BR-600-NH5	Halogen free	Sn-3.0Ag-0.5Cu	20-38	200
	PS31BR-600-NH11		Sn-3.0Ag-0.5Cu	20-38	170
	PS31BR-600A-LH1		Sn-3.0Ag-0.5Cu	20-38	200
	PS31BR-800-FC1	0201 chip soldering	Sn-3.0Ag-0.5Cu	5-15	210
	PS24BR-600A-HLS7	Low 1.1% silver	Sn-1.1Ag-0.7Cu-1.7Bi+α	20-38	180
	PS20BR-600A-HLS7	Low 0.1% silver	Sn-0.1Ag-0.7Cu-2.0Bi+β	20-38	180
	PS58BR-450A-KL1	Low melting point(SnBi)	Sn-58Bi	25-45	180

Naming of solder paste product

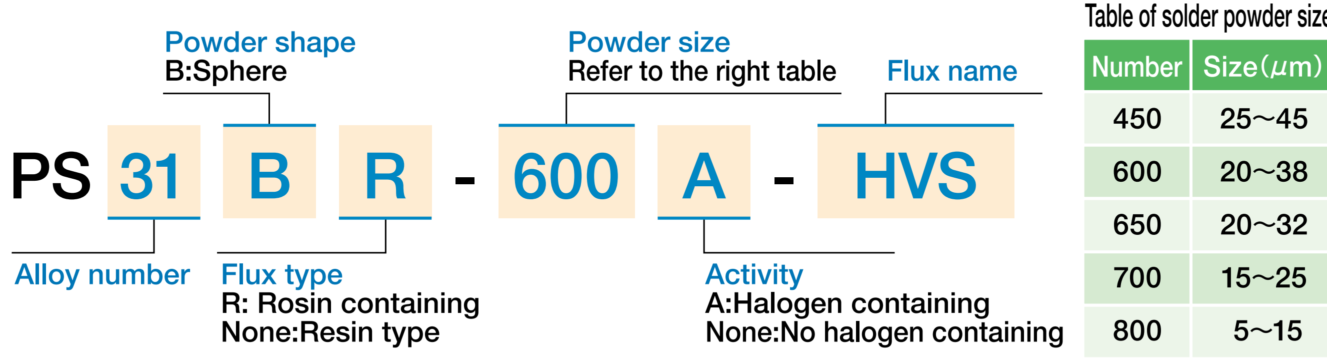


Table of solder powder size

Number	Size(μm)
450	25~45
600	20~38
650	20~32
700	15~25
800	5~15

Solder alloy list

Classification	Alloy number	Alloy composition	Sn	Ag	Cu	In	Bi	Sb	Pb	Other element	Melting point(℃)
Sn-Ag-Cu	31	Sn-3.0Ag-0.5Cu	Balance	3.0	0.5	-	-	-	-	-	219
Durability type	48	Sn-3.2Ag-0.5Cu-4.0Bi-3.5Sb-Ni-Co	Balance	3.2	0.5	-	4.0	3.5	-	●	223
Low 1.1% silver	24	Sn-1.1Ag-0.7Cu-1.7Bi+α	Balance	1.1	0.7	-	1.7	-	-	●	223
Low 0.1% silver	20	Sn-0.1Ag-0.7Cu-2.0Bi+β	Balance	0.1	0.7	-	2.0	-	-	●	225
Low melting(In)	37	Sn-3.5Ag-8.0In-0.5Bi	Balance	3.5	-	8.0	0.5	-	-	-	207
Low melting(Bi)	58	Sn-58Bi	Balance	-	-	-	58.0	-	-	-	138
Sn-Pb	10	Sn-37Pb	Balance	-	-	-	-	-	37.0	-	183
	60	Sn-36Pb-2Ag	Balance	2.0	-	-	-	-	36.0	-	190

Brazing materials and their lineup

We propose Brazing products to meet a wide variety of coating method.

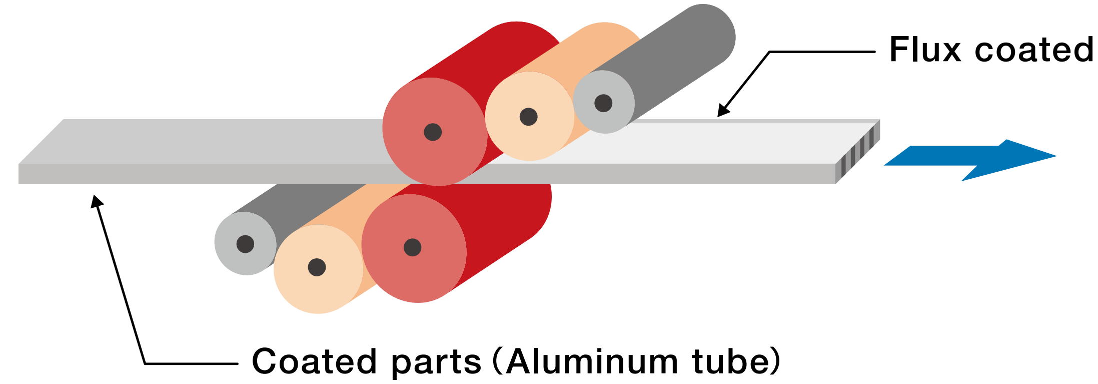
Coating method	Coating method	Characteristics
Flux containing NHP-NV112	Spray coating	· Suitable for the bent or curved surface coating
Flux containing NHP-X1002-39F	Flow coating	· Make it possible to coat partially to the parts
Flux containing NHP-X1001-50F Silicon containing NHP-X1003-50FS(EX) Zinc containing NHP-X2200-50Z	Roll coating	· Suitable for the flat surface coating · Good evenness · Good yield
Flux containing NHP-X109-50FG Metal containing NHP-X1600	Dispense coating	· Make it possible to feed properly to the parts · Good yield

※Handle a lot of brazing materials except the above.

NHP ~Paint flux for roll coating~

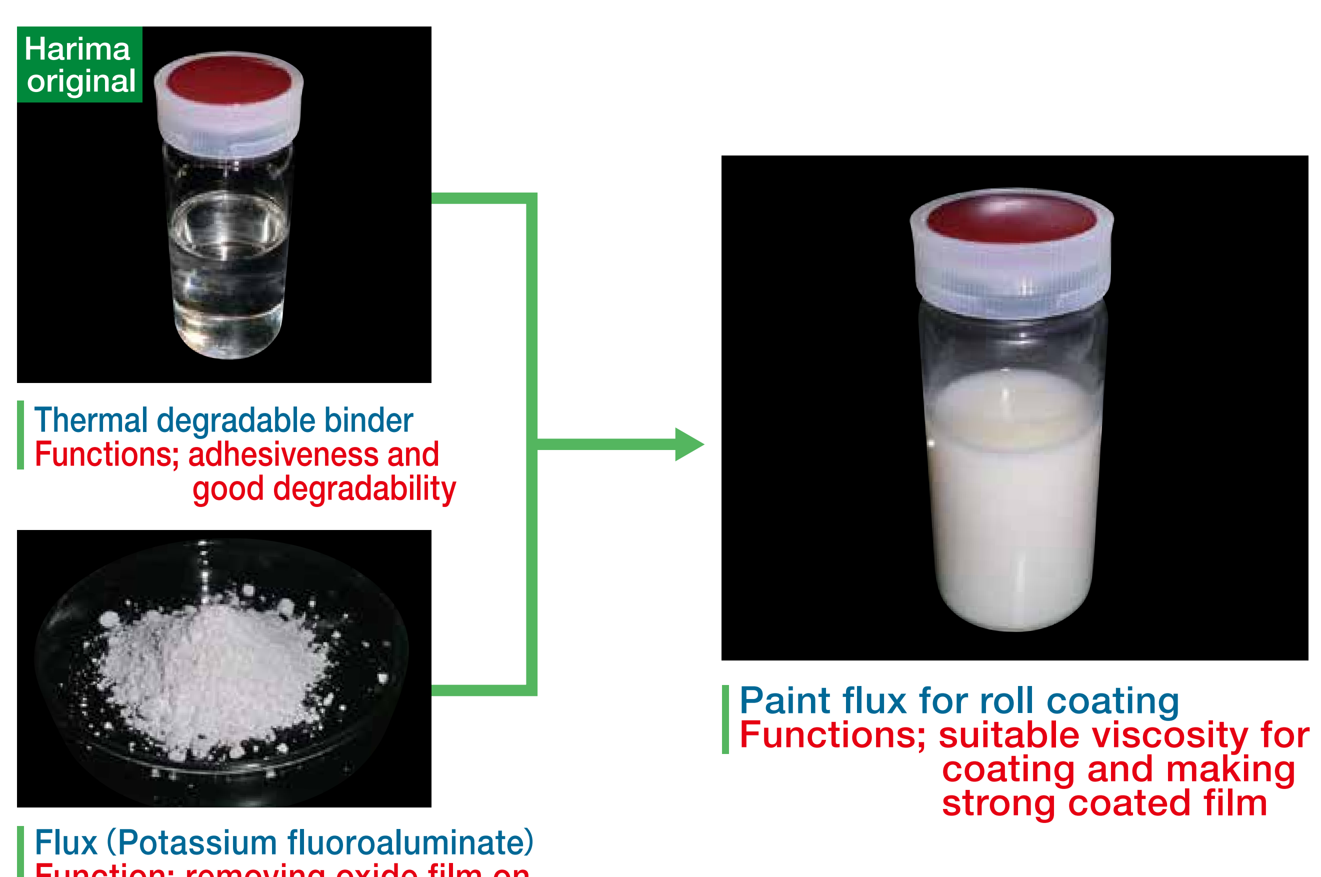
The paint flux provides good adhesiveness and excellent thermal decomposition derived from Harima developed binder.

What is roll coating?



The technology of making evenness coating by roll printing

Paint flux for roll coating



Thermal degradable binder
Functions; adhesiveness and good degradability

Flux (Potassium fluoroaluminate)
Function; removing oxide film on Aluminum surface

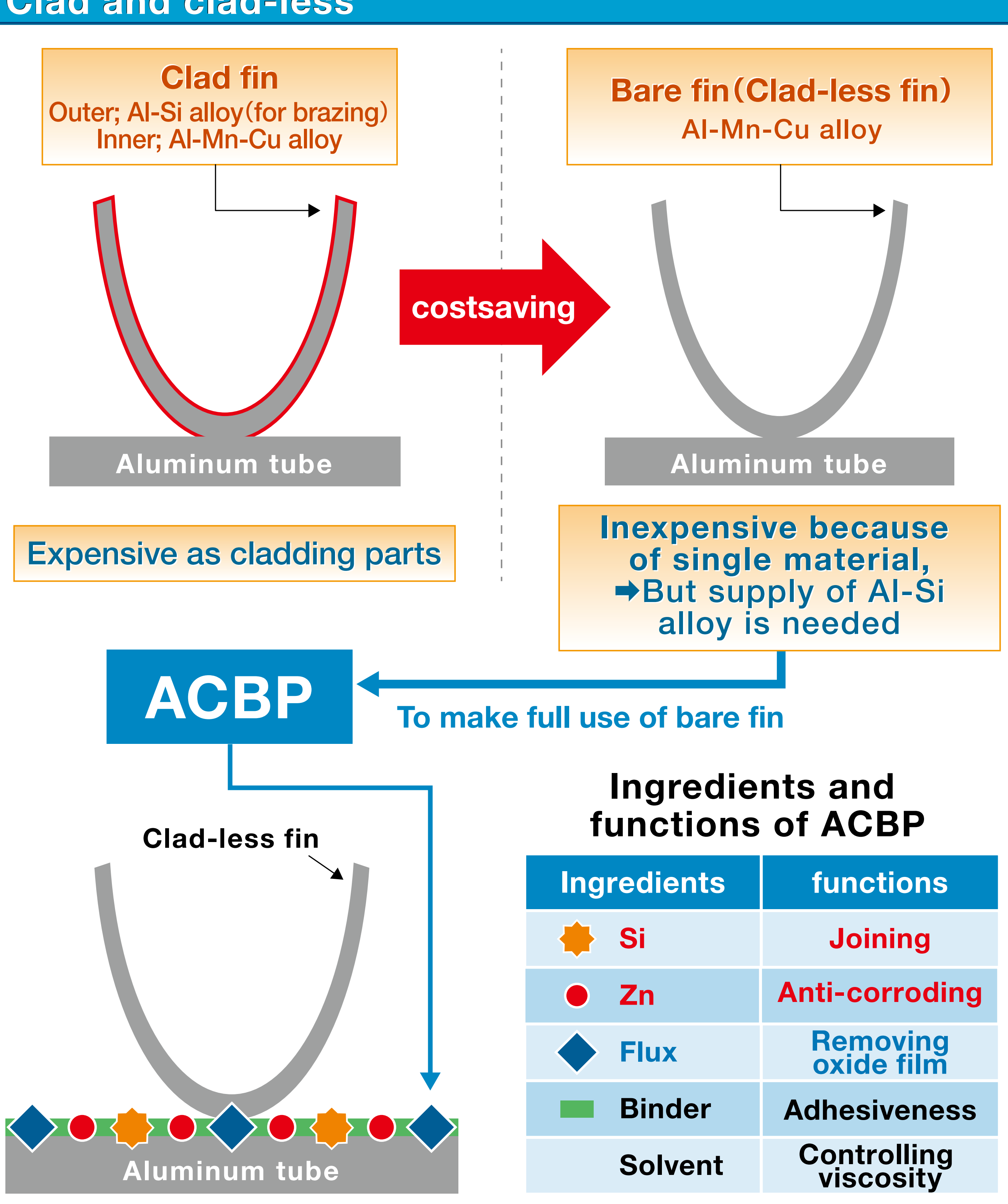
Paint flux for roll coating
Functions; suitable viscosity for coating and making strong coated film

Paint flux for roll coating makes it possible to coat by optimum flux amount

ACBP ~Anti-corroding clad-less brazing paint~

The brazing paint allows clad-less brazing as well as provides corrosion resistance on Al surface after brazing.

Clad and clad-less



Ingredients and functions of ACBP

Ingredients	functions
Si	Joining
Zn	Anti-corroding
Flux	Removing oxide film
Binder	Adhesiveness
Solvent	Controlling viscosity

Make it possible to provide not only joining but also anti-corroding

CP-800S,CP-1000S ～Copper paste for through-hole～

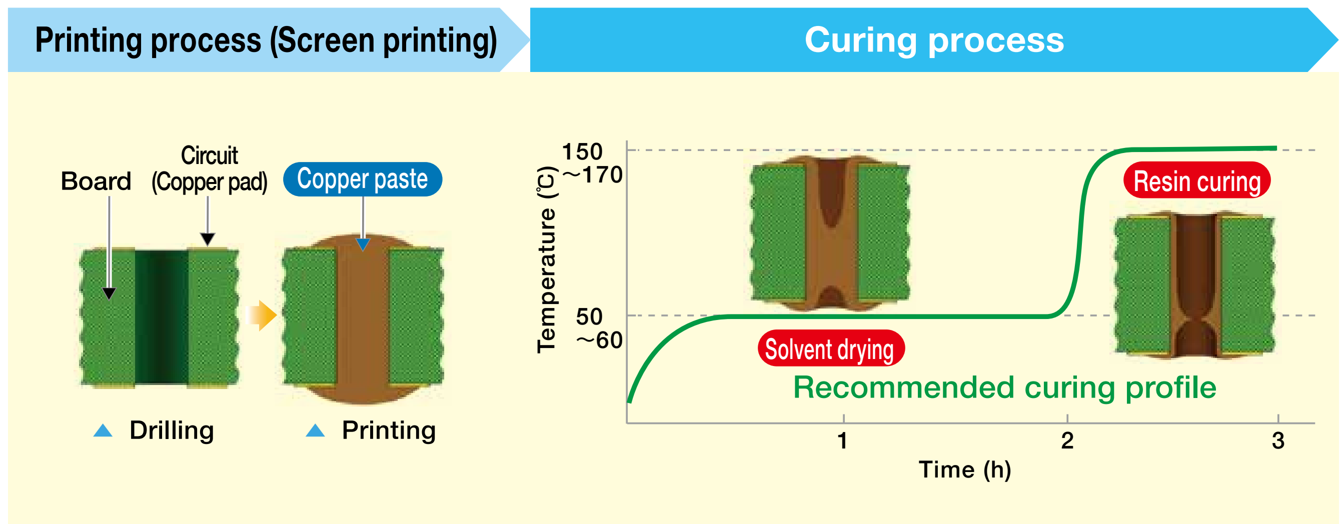
Highly-reliable copper paste for through-hole, available for automotive boards.

Features

- Compared to copper plating or silver paste, copper paste can reduce production cost.
- Available for small diameter through-hole and four-layer boards.
- Meets all the industrial standards of reliability evaluations required by electrical assembly field. Excellent electromigration resistance and available for wide range of board types, from for consumer to automobile.

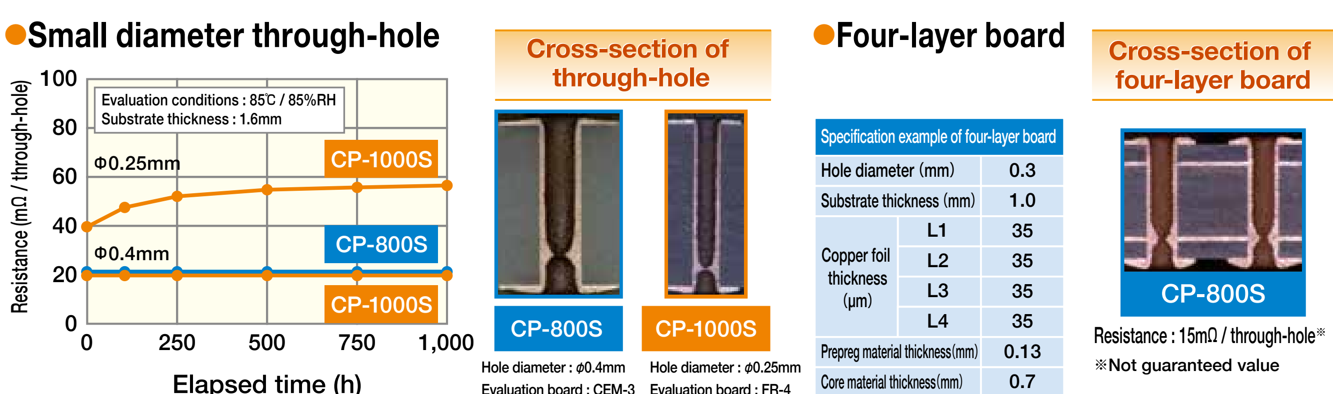
Printing and Curing process

- Compared to plating, copper paste printing process is simpler and produces less waste.
- Available for substrates of various thickness and hole size.



Application examples for small diameter through-hole and four-layer boards

- CP-800S used in various fields maintains high reliability even in the case of small diameter and four-layer boards.
- We offer CP-1000S(developed product) applicable for Φ0.25mm diameter through-hole with 1.6mm substrate thickness.



Specification example of four-layer board		
Hole diameter (mm)		0.3
Substrate thickness (mm)		1.0
Copper foil thickness (μm)	L1	35
	L2	35
	L3	35
	L4	35
Prepreg material thickness(mm)		0.13
Core material thickness(mm)		0.7

CP-5000D

~Copper paste for electronic parts electrode~

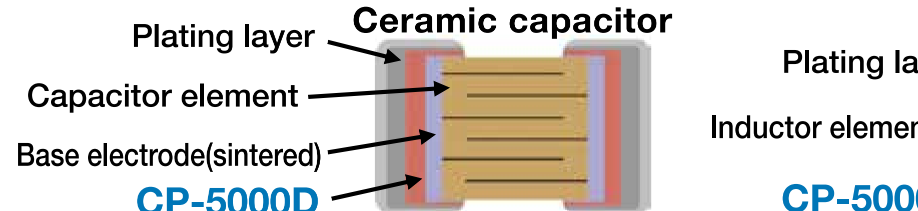
Resin cure type copper paste applocable for electrode of electronic parts.

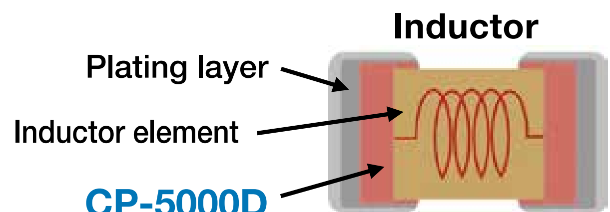
Features

- Replacing silver to copper reduces cost.
- Possesses the same performance as silver paste.
- Containing resin in copper paste ease the stress on components after mounted on the substrate.

Applicable position of copper paste for electronic component

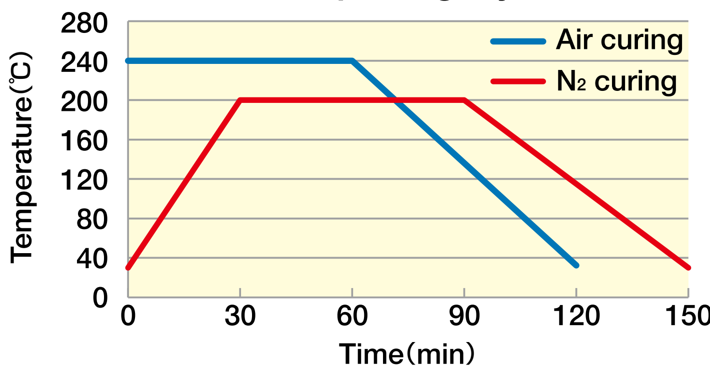
- Our copper paste is applicable for electronic component.

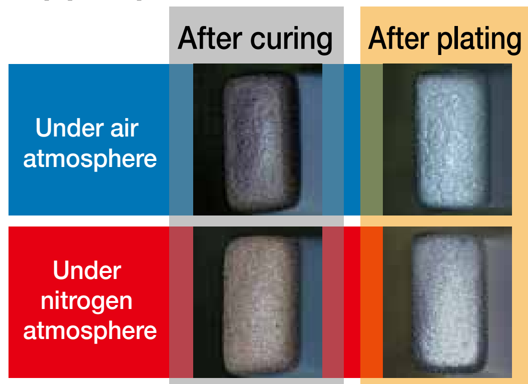




Curing profile

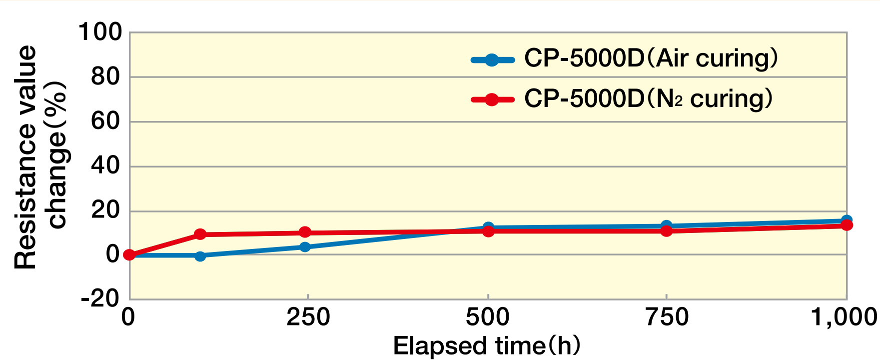
- Our copper paste is curable under both air and nitrogen atmosphere, and able to form plating layer on the cured copper paste.





Electric resistance value change of the cured copper paste

- Our copper paste maintains high reliability.



NH-3000D,NH-4000,SHB-200 ~High thermal conductive paste~

These silver pastes have higher thermal conductivity than solder.

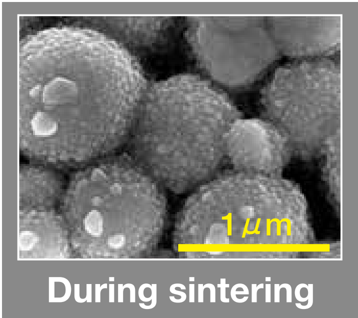
Features

- These pastes have high joining reliability.
- Due to mixing of silver nanoparticles and silver powder, dense sintered junction layer shows high thermal conductivity.
- New sinter paste SHB-200 is available for direct joining with Ni under pressurized process.
  It has been applied for a patent

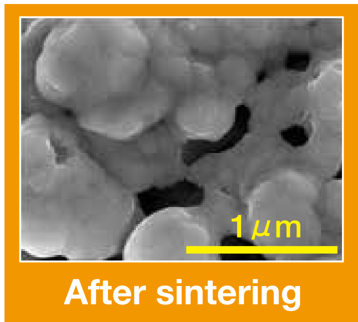
Mechanism of high joining strength and high thermal conductivity

- Silver powder and silver nanoparticles sinter closely to show high joining strength, high thermal conductivity and low volume resistivity

SEM observation result of the particle surface



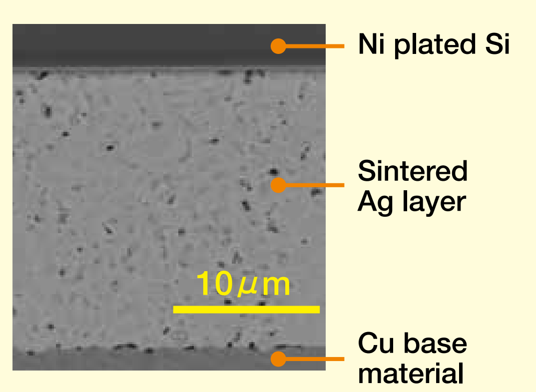
During sintering



After sintering

Silver nanoparticles promote fusion between silver powders to strengthen thermal and electronic moving pathways.

SEM observation result of cross-section of joining part



Specification (typical data)

Items		NH-3000D	NH-4000	SHB-200	additional notes
Curing condition		190℃×90min	150 ℃×90min	250℃×30min ＊)	＊)pressurized process is necessary
Joining strength	First	21N/mm^2 ＊1)	20N/mm^2 ＊1)	40N/mm^2 ＊2)	Element type ＊1)2mm□Au plated Si、＊2)5mm□Ni plated Si
	The rate of change after thermal cycle test	-10%	-10%	0%	Aftre 1,000cyc. -55/+125℃, each 30 min.
Thermal conductivity		95W/m·K	65W/m·K	240W/m·K	laser flash method
Volume resistivity		12μΩ·cm	14μΩ·cm	5μΩ·cm	4-point probes method
Element size		2mm□以下	2mm□以下	5mm□以下	—
Minimum thickness		10μm	10μm	20μm	—
Available base material		Au, Ag	Au, Ag	Au, Ag,Cu, Ni	—

Above data are representative value, not a standard value.

NPS-L,NPS-L-HB,NPG-J ~High Adhesive Nano Paste®~

Due to the stability of the dispersion, our product shows excellent printing features, and it is a suitable material for printed electronics.

Features

- Ensures high adhesion to variety of substrates.
- Metal film can be formed with the wide range of thickness.
- We also offer Gold Nano Paste® NPG-J for ink-jet printing.

High adhesion

- Due to our original metal composite technology, high adhesion to variety of substrate was achieved. Patent registered

Adhesion to substrate of metal film of NPS-L and NPS-L-HB

Substrate	PET	Cu	Ni	Glass	Alumina
Heating condition (under air atmosphere)	120℃×1h	120℃×1h	120℃×1h	400℃×1h	400℃×0.5h
Adhesion※	Class 0	Class 0	Class 0	Class 0	Class 0

※Test method : Cross-cut adhesion test(Former JIS K 5400)   Classification of adherence : (Excellent) 0・1・2・3・4・5 (Poor)

Specification(typical data)

- Since our product has favorable adhesiveness, it is able to form metal film on various substrates.

Item	NPS-L	NPS-L-HB	NPG-J
Component metal	Ag	Ag	Au
Heating condition	120℃×1h	120℃×1h	250℃×1h
Formable thickness	0.2~7µm	5~50µm	0.2~1µm
Volume resistivity	10 µΩ·cm	10 µΩ·cm	12 µΩ·cm
Pencil hardness	H	2H	3H
Printing method	ink jet screen	screen	ink jet
Adhesible substrate	Au, Ag, Cu, Ni, PET, Glass, Alumina, etc.		Au, Ag

Above data are representative value, not a standard value.