Transient Liquid Phase Sintering Paste

Masaki Takeuchi　*Fumitaka Ueno*
New Material Business Development Center, R&D Headquarters

1 Abstract

Due to the miniaturization of chip sizes and higher temperatures in the use environments, recent years have seen increasing demands for new bonding materials to replace lead-free solder. Solder is very useful for conductive bonding, but has limitations such as being unsuitable for repeated bonding reflow processes and for precise control of bonding positions. The "HT Series" is a die bonding paste that uses the transitional liquid phase sintering method of copper and tin. Features of the "HT Series" are that it can be bonded under the same temperature conditions as solder and it does not re-melt after bonding. Utilizing these features, we are developing the "HT Series" for use in automobile engines and headlights.

2 Characteristics of the Product

- After bonding, the product does not re-melt at the reflow temperature and can be used for repeated bonding (re-melting temperature > 400°C).
- There is no self alignment and no shape change even after bonding.
- The bonding material has low elasticity.

3 Background of the Development

In recent years, the demand for repeated bonding has increased because of the integration of the bonded substrate. Although a method for using lead-free solder with a different melting temperature is available as a method of repeated bonding, this method is not practical because the usable temperature range is small when considering the heat resistance of the peripheral component materials. Therefore, we are developing a bonding paste that uses transient liquid phase sintering (TLPS) of copper and tin alloy. Because the reaction of the molten tin alloy with copper particles at the sintering temperature forms an intermetallic compound with a high melting temperature, this paste does not melt even when bonding is repeated.

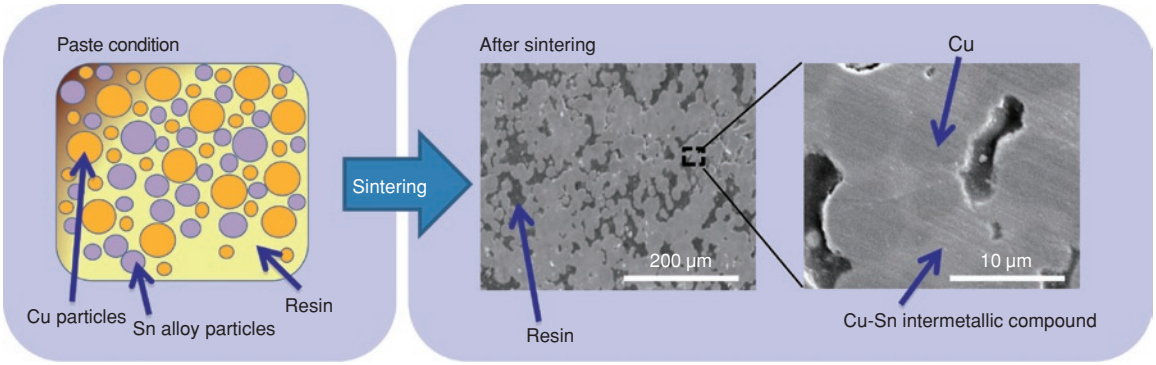


Figure 1　Structure of HT Series

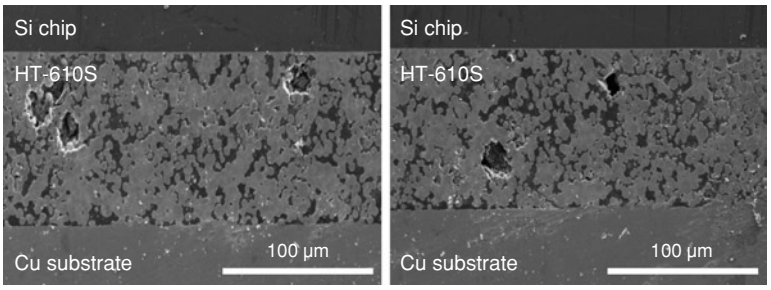
4 Technical Details

"HT-610S" is a bonding paste that combines the afore-mentioned metal composition and our unique thermoplastic resin to achieve the following at levels equivalent to lead-free solder: bonding processes, low elasticity, high heat resistance, shape-keeping performance, and the possibility of repeated bonding. **Table 1** shows the general characteristics of "HT-610S". "HT-610S" suppresses cracks even close to voids because the deformation of thermoplastic resin relieves stress and demonstrates high temperature cycle reliability (**Figure 2**). In addition, the shape does not change before and after sintering, and does not re-melt during repeated bonding (**Figure 3**). Because this paste is capable of bonding in temperature conditions equivalent to

those for lead-free solder, does not re-melt after bonding, and has high temperature cycle reliability, we are planning to apply it to automobile component materials.

Table 1 Properties of "HT-610S"

Item	Unit	HT-610S	Pb-free solder SAC305	Sintered silver paste
Application	—	Die bonding material	Mounting material	Die bonding material
Conductor	—	Cu, Sn, etc.	Sn 96.5-Ag 3.0-Cu 0.5	Ag
Resin	—	Thermoplastic PI	—	—
Bonding condition	—	260℃ / N_2 Reflow	260℃ / N_2 Reflow	250℃ / Hot Press
Re-melting temp.	℃	> 400	220	960
Coefficient of thermal expansion	ppm/℃	19	19	20
Elastic modulus	GPa	3.5	31	30
Electrical resistivity	Ω・m	$5.0x10^{-7}$	$1.1x10^{-7}$	$2.0x10^{-8}$
Thermal conductivity	W/(m・K)	43	55	400
Reliability test	cycle	3000	2000	3000
	condition	−65℃ to 175℃	−40℃ to 125℃	−65℃ to 175℃
Whisker generation	—	No generation	Generation	No generation
Self-alignment	—	No self-alignment	Self-alignment	No self-alignment



Before temperature cycling test　　After temperature cycling test

Figure 2 Cross-sectional images before and after temperature cycling tests (From –65°C to 175°C, 3000 cycles)

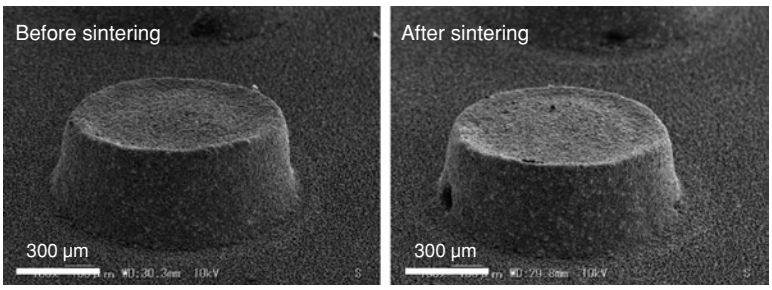


Figure 3 Shape change before and after sintering

5 Future Business Development

・Development of bonding materials for heat dissipation

[References]

1) Gurth, K. et al."New assembly and interconnects beyond sintering methods"international exhibition & conference for power electronics intelligent motion, renewable energy & energy market 2010. Nuremberg, PCIM, 2010 pp. 232-237

2) Element technology and reliability of next generation power semiconductor bonding CMC Publishing Co., Ltd.