

# Void Generation Method Yields Low-Void Solder Paste

Since the Waste Electrical and Electronic Equipment (WEEE) and the Restrictions on the use of Hazardous Substances (RoHS) directives came into effect in July 2006, the use of six toxic substances, including lead has become restricted. To date, solder manufacturers have completed the shift from using the conventional lead-contained solder pastes to lead-free solder pastes.

Compared to lead solders, the SAC (Sn3Ag0.5Cu), a typical lead-free alloy, has strong reactivity as well as high surface tension and melting point. However, a rise in the melting point has led to an increase in the pre-heat temperature and the oxidation of solder powder, causing many cases of unwetting and defective jointing. These defects have been almost solved as a result of the improvements in solder paste flux and the changes in mounting conditions. However, there are still no clues on the reduction of voids that

tend to develop due to high surface tension. The voids occurring on a large pat may involve not only the decrease of jointing reliability, but also the defective parts due to poor radiation performance if the pat is used in a head sink, thus becoming a major issue. A host of customers have requested improvements and new developments to reduce the voids, even today when lead-free solders have become more common.

This article will outline the M420 Series, an ultra low-void solder paste developed by KOKI Co., Ltd. using a new concept.

## Void-Generating Mechanism

The void-generating mechanism begins when the flux solvent starts to vaporize at the time of pre-heating in the mounting process. In addition, the oxidation of solder powder, polar zone, and flux starts as well due to the heat (Fig. 1).

When entering the main heating stage, the volatilization of solvent advances further, and the volatilization of low-volatility components in additives and rosin forms air bubbles. In addition, the reaction of the organic acid and oxidized metals pro-

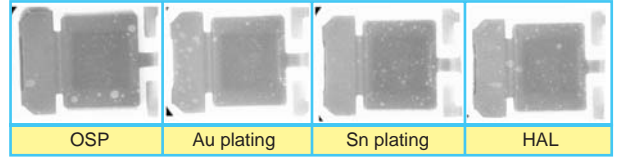


Fig. 3: Summary of void evaluation results

duce water to increase the air bubbles. The air bubbles that grow fairly big in size are pushed out when the part is put in.

In the latter half of the main heating process, the solder surface becomes oxidized, and because of the oxide film, it will be more difficult for the air bubbles formed to pass out. The air bubbles continue to develop due to vaporization and the reaction of added materials and lead to solidification. As a result, a number of voids occur.

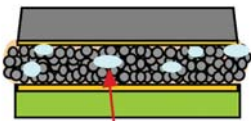
## Traditional Low-Void Solder Paste

The conventional low-void products were developed under the concept of reducing voids generated during the pre-heat and main heating stages, and trying to force them out.

There are two approaches to implement this concept: (1) increase flux fluidity to allow the void to flow easily, and (2) improve the solder wettability and strengthen the pressure of the part to force voids out. These two approaches have been taken to reduce voids. However, in the first method, a problem arises in which the flux flowing in the early stage causes the solder to be exposed during pre-heating to accelerate the oxidation, giving rise to unwetting. In the second method, adding large amounts of organic acids and halide tends to result in defects, such as the decrease of electric reliability or migration development and the viscosity change due to time change.

Until today, KOKI has been promoting its solder product development using the concept described above. However, the company has realized the limitations of these approaches and has started the development of ultra low-void products using a totally new concept.

Void behavior diagram during reflow



Solvent vaporizes from heat during pre-heating

Grown voids are pushed out



Voids occur due to the reaction with metallic salt  
 $MO + RoCOOH \rightarrow (RoCOOH)_2M + H_2O$

Oxide film



Voids become unable to escape due to the oxide film.

Void behavior diagram during reflow



Air bubbles generated by additive reaction capture small voids to force them out.



Additive reactions last for a short time and the amount of voids after solidification is less.

Fig. 1: Void-generating mechanism

Fig. 2: Using M420 Series solder paste

## Development Concept of M420 Series

The M420 solder paste is a product developed by adopting an approach totally different from the existing low-void solder pastes based on a new concept of increasing the amount of generated voids and driving out the voids with the voids (Fig. 2).

As in the case of existing products, air bubbles develop due to the volatilization of solvent up until main heating.

When entering the main heating process, a large amount of gas is generated due to the decomposition of the new additive agent. That gas absorbs and discharges the void formed as a result of the reaction of organic acid and metals and the volatilization of solvent.

The reaction of the new additives will end when the temperature reaches its peak, and gases will not be generated afterwards.

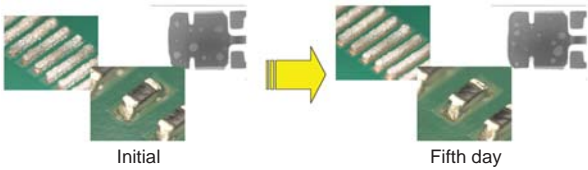
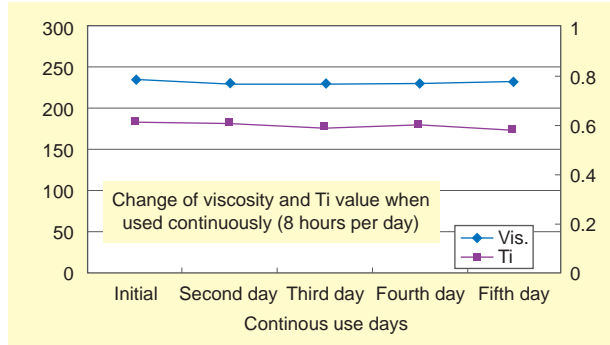


Fig. 4: Viscosity and Ti value level at continuous use

Table 1: Specifications of M420 Series

Product	S3X48-M420	S3X58-M420
Alloy composition	Sn96.5, Ag3.0, Cu0.5	
Melting point (°C)	217-219	
Solder particle size (μm)	20-45	20-38
Product flux content (%)	11.5	
Viscosity (Pa.S)	220	
Copper plate corrosion test	Passed	
Solder expansion rate (%)	> 78	
Tack time	> 72 hours	
Shelf life (below 10°C)	6 months	

This will result in a low level of voids as has never seen before.

## Evaluation Results of M420 Series

Fig. 3 summarizes the void evaluation results in the mounting substrate.

It can be seen that the amount of voids in the large pat area, where the reduction of voids has been considered to be difficult for lead-free solder paste up to now, has become extremely small. The voids will not increase even when changing the substrate surface processing, realizing a stable low-void condition (Table 1).

Another characteristic of the M420 Series is that there is almost no deterioration resulting from continuous use. The M420 Series uses an additive that does not react at normal temperature, so the solder powder and the additive

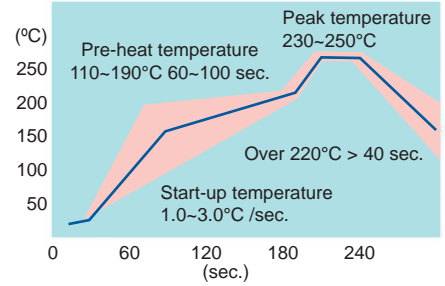


Fig. 5: Increased durability of solder paste

hardly react at normal temperature. As seen in Fig. 4, there are small changes in viscosity and Ti value at the time of continuous use, and printability, fine fusibility and voids are stabilized without deterioration.

## Conclusion

The M420 Series adopts a system, which generates an excessive amount of voids with the help of a new additive agent and discharges them in bulk, to realize the low-void condition. As a result, the decrease on the number of voids in the large pat area, which was considered to be difficult for lead-free solder pastes, becomes possible and so does the improvement of radiation performance of the heat sinks and others. In addition, by increasing the durability for continuous use of solder paste, the amount of disposal is also drastically cut down, which has improved economic efficiency (Fig. 5).

## About This Article:

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