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Pb-FREE SOLDER PLATING

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Abstract

In the future, restrictions are likely to be imposed on the use of lead in the electronics industry. In dealing with such a move, we have been developing Pb-free Sn-Ag plating process to replace presently available Sn-Pb process. In this paper, the result of a basic comparison test between Sn-Pb plating and Sn-Ag plating is reported.

Key words : *Pb-free, Sn-Ag, Meling point, Solderability, Environment-free*

1. INTRODUCTION

Triggered by water contamination by Pb in America, restrictions are likely to be imposed in Japan in the near future on the use of Pb that is harmful for the human body. Accordingly, there is an urgent demand for Pb-free solder plating process that may substitute for the existing Sn-Pb process, especially in the electronics industry and therefore the development of such process is a matter of urgent necessity.

A Pb-free solder material is required to have the following features:

* Environment-friendly.
* Assurance of stable supply.
* Good electrical and thermal conductivity.
* No cost increase.
* Melting point not higher than of Sn-Pb.
* Sufficient mechanical strength.

Taking the above features into consideration, the most promising metal Pb-free process seems to be an alloy which contains Sn as its main component and one or two types of other metals from among Ag, Bi, Zn, Cu, etc. to assure a desirable melting point and strength.

In this paper, the result of a basic comparison test between the exiting Sn-Pb plating and Sn-Ag plating, which is under development, is reported.

2. STANDARD BATH COMPOSITION AND OPERATING CONDITIONS

The standard bath composition and operating conditions of Sn-Ag plating are as shown in Tables 1 and 2, respectively.

Table 1. Standard bath composition and concentration

Component	Sn/Ag=96.5/3.5
EBASOLDER SN	400g/L (40g/L as Sn)
EBASOLDER AG	4g/L (0.4g/L as Ag)
EBASOLDER A	160g/L (150g/L as free acid)
Additive A	2g/L
Additive B	4g/L
Additive C	40mL/L

Table 2. Standard operating conditions

Item	Condition
Bath temperature	35 to 45℃
Cathode current density	5 to 15 A/dm²
Anode	: Sn anode
Filtration	Continuous filtration (Cartridge mesh of 5㎛ or less)
Agitation	Jet stream agitation by the use of pump circulation in combination with cathode rocker

3. CHARACTERISTICS OF PLATING FILM

3. 1 Melting Point of Plating Film

The melting point of the plating film of Sn-Ag alloy with a variation in Ag content was measured by Differential Thermal Analysis (DTA) (Table 3).

Table 3. Melting point of Sn-Ag plating film

Sn/Ag	Melting point(℃)
98/2	221.9
96.5/3.5	221.1
93/7	220.4
90/10	221.1

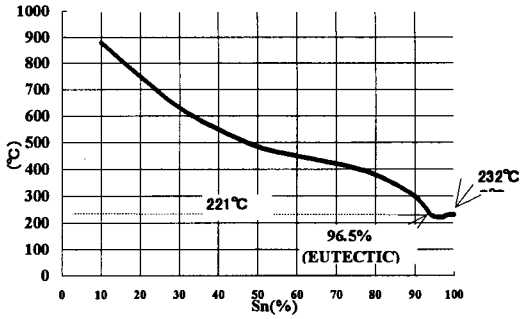

Fig. 1 Phase diagram of Sn-Ag

3. 2 Plating Film Composition Analysis

Copper test pieces plated with Sn-Ag were examined by an X-ray diffraction system.

Table 4. Composition of Sn-Ag plating film

	Film thickness (㎛)	Sn%	Main component	Subcomponent	Small amount	Very small amount	Extremely small amount
①	9.26	99.12	β-Sn	-	-	-	γ-Ag_3Sn
②	9.30	96.86	β-Sn	-	-	γ-Ag_3Sn	-
③	10.31	90.17	β-Sn	-	γ-Ag_3Sn	-	-

Silver was not found as simple substance in the film but always in the form of compound γ-Ag_3Sn. As the content of Ag increased, that of γ-Ag_3Sn also increased.

3. 3 Solderability (Measurement of Zero-cross Time)

Test items:

a. Type of plating (Sn-Ag plating and Sn-Pb plating)

b. Difference in alloy composition

Solderability test conditions :

Solder dip : Sn/Pb eutectic, 240℃

Speed : 10㎜/sec., Time : 5 sec., Depth : 5 ㎜, Inactivated . (Type R) was used

Test piece(10×20㎜ Cu plate) preparation conditions

	Sn-Ag plating	Sn-Pb plating
Metal	40g/L	40g/L
FA	150g/L	110g/L
Additive	40mL/L	20mL/L

Temperature	40℃
Stirrer agitation	Apporx. 1000rpm
Cathode rocker	Apporx. 5m/min
Current density	10A/dm^2
Targer film thickness	8㎛

The measurement results of solderability of both Sn-Ag and Sn-Pb plating are shown in Table 5 and Fig. 3.

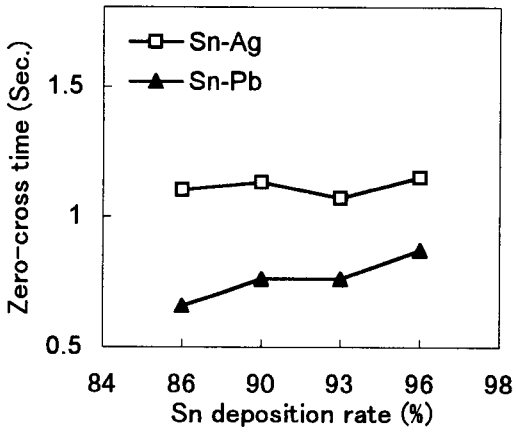

Fig. 3 Solderability

Table 5. Solderability(inactivated flux used) Unit Second

Sn percentage (%)	Sn-Ag plating	Sn-Pb plating
	Zero-cross time	
96	1.15	0.87
93	1.07	0.76
90	1.13	0.76
86	1.10	0.66

CONCLUSION

For the use of Pb-free process, the development of not only a plating process but also a new type of alloy paste that may substitute for the exiting eutectic crystal solder is essential. Before being used as a total process, Pb-free process seems to have a lot of problems to be solved, such as insufficient adhesion strength of paste plating film, thus resulting lack of reliability, etc.

In this paper, the basic characteristics of Sn-Pb plating and Sn-Ag plating were compared. We will make every effort to put Sn-Ag plating into practical use as Pb-free process instead of existing Sn-Pb plating by performing further tests.