mat-tech
development & testing

mat-tech
innovative soldering & brazing

Solder as Alternative Joining Material for Solar Panel Assembly

N. van Veen, A. Kodentsov, L. Krassenburg, M. Biglari, E. Brom
Mat-Tech BV, Ekkersrijt 4605, 5692DR, Son, The Netherlands

I. Introduction

In the quest for replacements for the Ag-filled conductive adhesives in the solar panel fabrication, soldering with low-temperature Pb-free alloys is a viable option.

Joining of through vias interconnects of Si-based individual cells will be performed via metallization layer made by sintering Ag-based paste containing frit comprising Bi_2O_3 and other oxides.

For an alternative joining process to be adopted, it is essential that it will be compatible with existing electronic packaging technologies and allow to assemble process to be developed in a reliable and cost-effective manner.

The solder technology has to be developed that fits within the temperature/time profile for the lamination step in the current fabrication process.

Also, re-use and recycling aspects of the newly introduced materials are to be taken into consideration.

II. Solder alloy selection

Near-eutectic solder alloy Bi57Sn42Ag1 in paste form was used in the present study shown in Fig. 1.

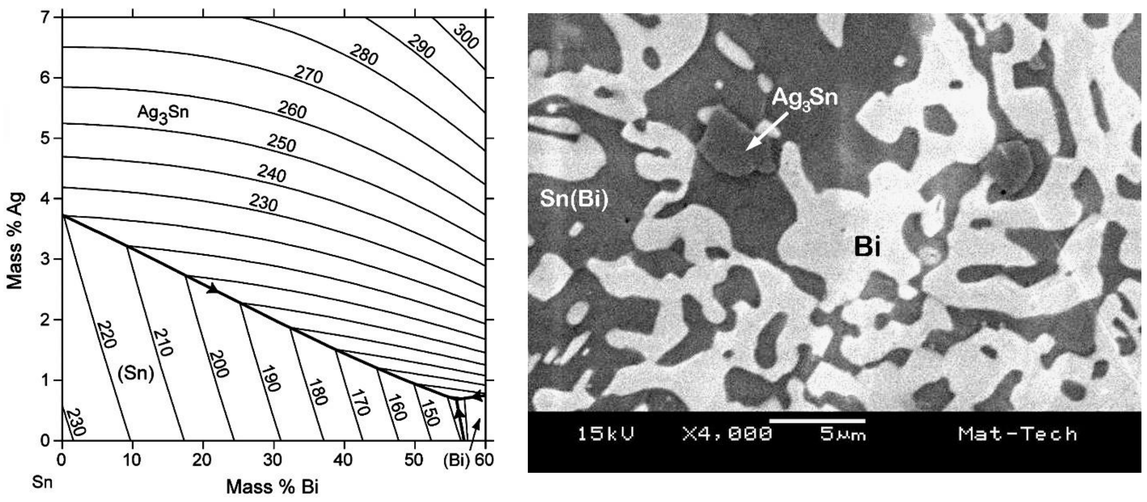

Fig. 1: Liquidus surface in the Sn-rich domain of the Sn-Bi-Ag system on the left [1] and on the right the Secondary Electron Image (SEI) showing microstructure of the Bi57Sn42Ag1 solder alloy after reflow at 170°C.

The choice of the solder alloy is dictated by mainly three factors:

This Pb-free material is inexpensive and available in sufficient quantity.

Liquidus temperature of this solder is around 150 °C, which is compatible with the current processing conditions (Fig. 1 left).

Small additions of Ag significantly improve ductility of the binary Bi-Sn eutectic alloy [2] and reduce leakage of Silver form the metallization into the liquid solder.

III. Solderability assessment for Ag-based thick film metallization

In soldering of the metallized Si-substrates, a good wetting of the Ag-based metallization by molten Bi57Sn42Ag1 solder is important.

It was found that depending on the cell manufacturer, wetting behaviour of liquid Bi57Sn42Ag1 solder on Ag-based metallization may differ significantly: from “non-wetting” on the product received from supplier A (MT-18-089 on the left) to “very good wetting” in the case of supplier B (MT-18-090 in the center) and supplier C (MT-18-091 on the right)

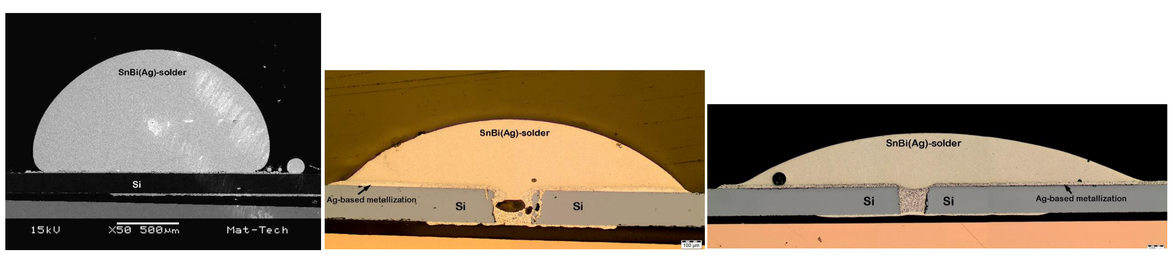

Fig. 2: Cross-sectional view of the “sessile drop” of the Bi57Sn42Ag1 solder after reflow on Ag-based metallization in the test samples received from (left) supplier A (Secondary Electron Image); (center) supplier B (bright-field optical image) and (right) supplier C (bright-field optical image).

IV. Surface condition as determining factor

Conditions of the metallized surface (roughness, presence of voids and remnants of frit) in the samples provided by different suppliers are different.

In samples MT-18-090 from supplier B and MT-18-091 from supplier C, the surface of the Ag-based metallization in the areas of the vias was found to be rather smooth and contains not many voids (Fig. 3 center and right).

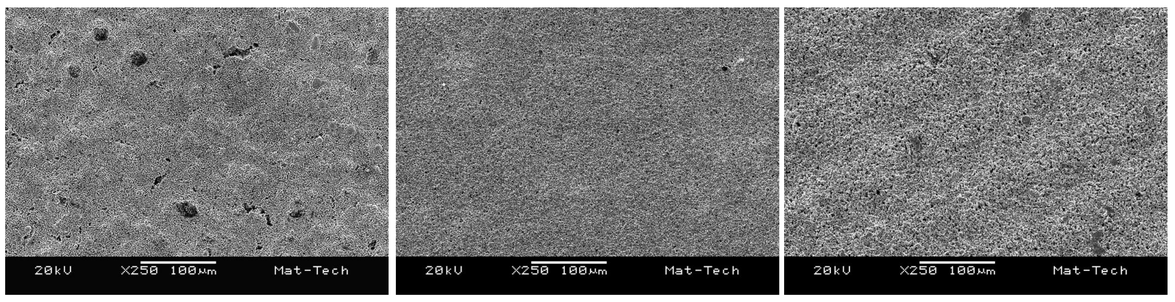

Fig. 3: Morphology of the Ag-based metallization (SEIs) on the “back-side” of the via in the samples MT-18-089 from supplier A (left), MT-18-090 from supplier B (center) and MT-18-091 from supplier C (right).

No constituents of the frit (Bi. Mn, Si) have been detected (in terms of EPMA) on the metallized surface in samples MT-18-090 form supplier B and in MT-18-091 from supplier C. A typical EPMA spectrum is given in Fig. 4 (right).

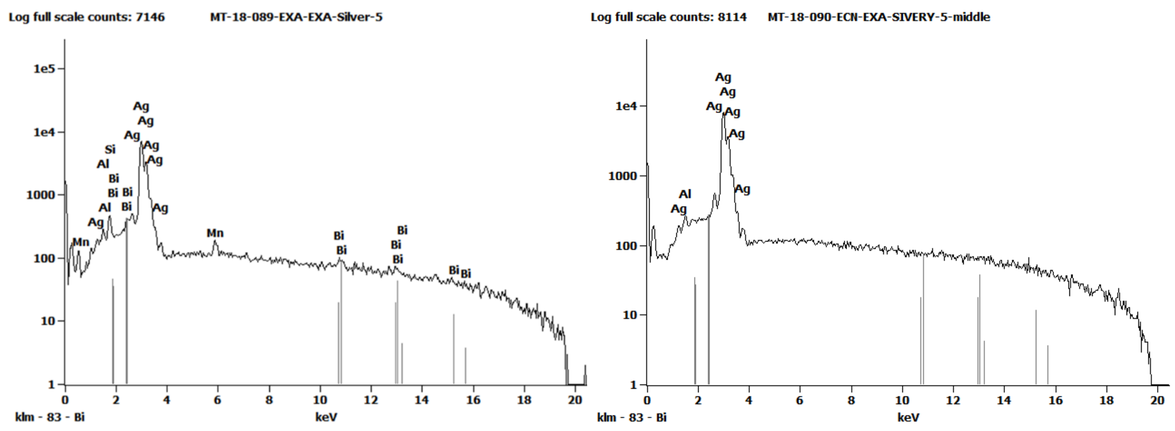

Fig. 4: Characteristic X-ray spectra taken from the area at the surface of the Ag-based metallization layer in the samples MT-18-089 (supplier A), MT-18-090 (supplier B) and MT-18-091 (supplier C). (Note. X-ray intensities are presented in a logarithmic scale and expected position of the X-ray characteristic lines for Bismuth are indicated by “vertical bars”.)

The quality of the Ag-based (thick) metallization layer has a profound influence on its wettability by the Bi57Sn42Ag1 liquid alloy, and hence, on the solderability

V. Concluding Remarks

Quality (surface integrity) of the Ag-based metallized surface has a profound influence on the solderability with Bi57Sn42Ag1 alloy

In the case of samples MT-18-090 (supplier B) and MT-18-091 (supplier C), surface of the Ag-based metallization is rather smooth (contains not many voids), and no constituents of the frit (Bi. Mn, Si) was detected (in terms of EPMA) on the metallized surface

That is why, wetting of these metallizations by the molten Bi57Sn42Ag1 solder alloy is very good, which is in line with the observations reported in the literature [3]

VI. Acknowledgement

The work was partially funded by the Dutch Ministry of Economical Affairs under number TEUE117017.

VII. References

[1] U.R. Kattner, W.J. Boettinger, *J. Electron Mat.*, **23** (1994) 603-610

[2] M. McCormack, H.S. Chen, G.W. Kammlott, S. Jin, *J. Electron Mat.*, **26** (1997) 954-958

[3] S. Achmatowicz, E. Zwierkowska, “Lead Free Thick Film Circuits”, in “*Materialy Elektroniczne*”, **Vol. 34**, 2006, pp. 5-47