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Copper Influence On The Melting Point Of Sn – Bi Alloy

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Abstract. The influence of adding copper to the low melting point soldering alloy of a composition Sn –Bi has been studied by Differential Scanning Calorimetric (DSC), to detect the melting point of the alloy after adding different weight percent of copper. The produced alloys were analyzed by XRD and optical microscopy for microstructure characterization. The hardness has been tested as ductile form.

Keywords: Soldering Alloy ,Melting Point, DSC.
PACS :81.05 BX

INTRODUCTION

A solder is a fusible metal alloy with a melting point or melting range Of (90 to 450) C^0 (200 to 840 F^0), used in a process called soldering where it is melted to join metallic surfaces. It is especially useful in electronics and plumbing. Alloys that melt between (180 and 190) C^0 are the most commonly used.[(1)] .Significant manufacturing cost reduction can be realized with lower-temperature melting and lead-free solder alloy According to the European Union Waste Electrical and Electronic Equipment Directive (WEEE) and Restriction at Hazardous Substances ,Directive (ROHS),lead had to be eliminated from electronic systems by July 1,2006[(1)].More over the lead-alloy of eutectic Sn-Pb solder yield problems during surface mount assembly .In order to alleviate these problems there is a push to lower peak reflow temperature during the soldering process[(2)]. The most common alloy used in reflow soldering is eutectic Sn-37Pb of melting point 183C^0 [(3)].Alternative solder alloys with lower melting points then these of eutectic Sn-37Pb has been developed and often considered for many applications[(4)].

Experimental Procedure

The elements Sn, Bi and Cu melted to produce the alloy were of high purity (99.99), melted in ceramic tube furnace under inert atmosphere. Three alloys were prepared for sake of comparison, of (0.5, 1and 1.5) Cu wt. %. The Differential Scanning Calorimetric (DSC), for the alloys were detected upon heating at scanning of 5C^0/min to determine the heat extraction that is conducting the onset melting point .The alloys were examined by XRD (Philips vertical power diffract meter type PW1050) was used. While optical microscopy was used to characterize the microstructure feature.

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RESULT AND DISCUSSION

The thermal behavior were found for all alloy .Figure (1) is a typical DSC profile of the alloy Sn42.5 –Bi57 with 0.5 wt.% Cu. As have been continues slope without change on per melting. Figure (2) shows the melting portion of the heat extraction well, the temperature of this 133.41 C^0 (Onset)[6] liquids temperature was 135.43 C^0 (Peak) for the alloy Sn42 –Bi57with 1 wt.% Cu .While the alloy Sn41.5 –Bi57 with 1.5wt.% Cu, figure (3) indicated the lowest melting point ,as the solid solution Sn-Bi –Cu was formulated for both alloys having 1 and 1.5 wt % Cu that can effected its melting point.

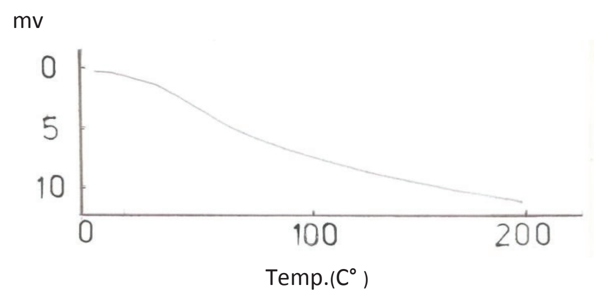


FIGURE 1. Typical Differential Scanning Calorimetric (DSC) profit for the Sn42.5-Bi57-0.5wt.% Cu Alloy upon heating at scanning rate $5C^0$/min.

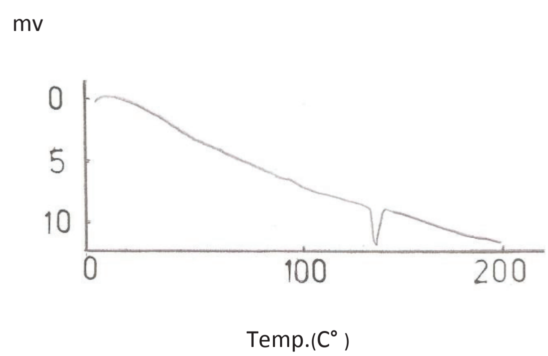


FIGURE 2. Typical Differential Scanning Calorimetric (DSC) profit for the Sn42-Bi57-1wt.% Cu Alloy upon heating at scanning rate $5C^0$/min.

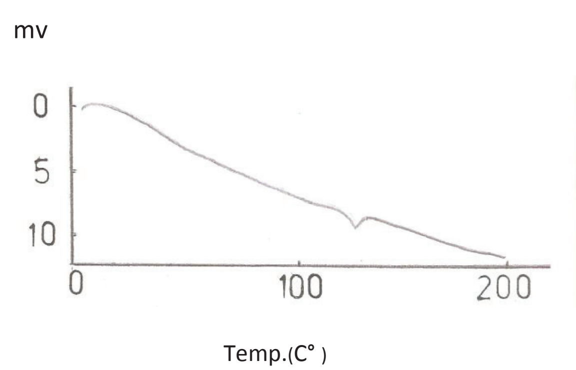
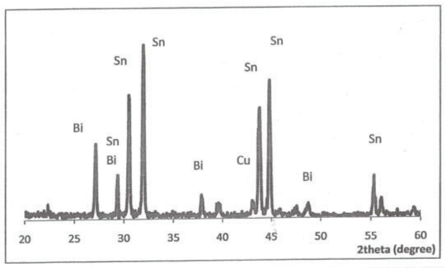
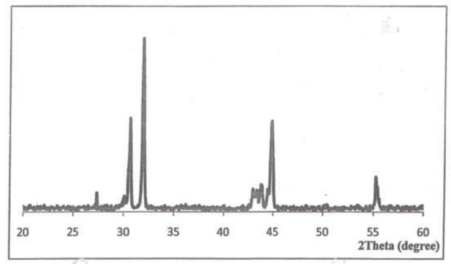


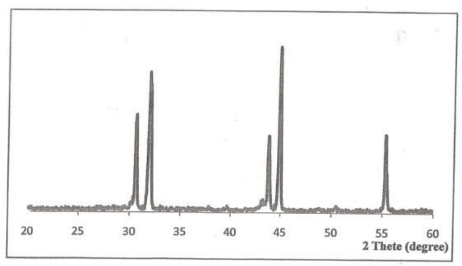
FIGURE 3. Typical Differential Scanning Calorimetric (DSC) profile for the Sn41.5-Bi 1.5wt.%Cu Alloy upon heating at scanning rate $5C^0$/min.

The x-ray diffraction pattern for the Bi42.5- Sn57with 0.5wt% Cu alloy figure (2 a) shows the presence of the Bi, Sn-Bi eutectic alloy consisted of a week phase mixture from Bi- Sn - Cu solid solution. At 1wt% Cu figure (2 b) the Sn-Bi –Cu solid solution more clear to be identify in addition to the presence of Sn-Bi eutectic phase. While the alloy of 1.5wt% Cu figure (2 c) the relevant pattern reflect the stronger eutectic Sn-Bi- and solid solution.





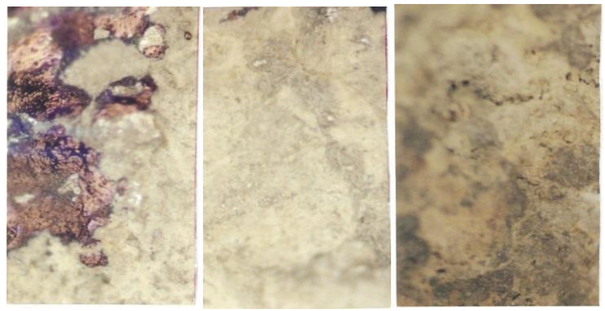
(a) **(b)**



(c)

FIGURE 4. X-ray Diffraction Pattern of the Sn-Bi-Cu alloy : a) 0.5 wt.% Cu, b) 1wt.%Cu and c)1.5wt.%Cu **.**

The microstructure of the Sn-Bi- 0.5wt% Cu alloy reveals the presence of the Sn-Bi eutectic alloy phase mixture at fine Bi –rich solid solution (bright colored area) and Sn –rich solid solution (dark colored area)as shown in figure (3a) .Remarkable microstructure changes were observed after completely melting and homogenate was achieved as shown in figure (3b). The Sn-Bi-1wt% Cu and Sn-Bi-1.5wt% Cu melting produced it appears that was mainly associated with the coarsening of the eutectic microstructure and the solid solubility of the phase to achieve the homogenate as shown in figure (3C).



(a) **(b)** **(c)**

FIGURE 5. Optical Micrographs of (a) Sn-Bi 0.5 wt.% Cu alloy, (b)Sn-Bi-1wt%Cu (c) Sn –Bi-1.5wt% Cu .

The Brinel hardness of value (2HRB) for the Sn42.5-Bi 57- 0.5 wt% Cu alloy was obtained at room temperature, at 1.5 wt% Cu. The HRB increased to be(8HRB), while at 1.5 wt % Cu, rabid increasing in the hardness value of (15HRB) these results were enhance that's we got from the microstructure observation. The Harding of microstructure was caused by solid –solution of Bi into Sn-rich solid solution [(9)]

CONCLUSION

The lowest melting point of the Sn41.5-Bi57with 1.5 wt.% Cu alloy solder was found to be134.95 C^0. The microstructure change of Sn-Bi eutectic alloy was observed after completely melting and homogenization with best softening hardness as solid- solution of Bi into Sn-rich solid solution.

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