PREPARATION AND MANUFACTURING LEAD FREE SOLDERING ALLOY

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Abstract . A soldering alloy composition Sn_{40}-Bi_{60} has been manufactured by quenching method to achieve the both cast and wire shape. Differential scanning calorimetric (DSC) was done to study the melting behavior for a large portion of the alloy melts sharply at a approximately 136 C^0 ,the melting point of Sn-Bi . X-Ray diffraction and optical microscopy were used to analyzed its microstructure characterization . The hardness of the alloys has been tested and find at a value 2 HRB as ductile form .

Keywords: *Soldering alloy , lead free ,DSC .*

INTRODUCTN

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]

The word solder comes from the Middle English word soudur,via Old French solduree and soulder , from the Latin solidare , meaning ' to make solid ' . In North America "solder" is pronounced with a silent L . solder can contain lead and or flux but in most cases solder is now lead free.

Tin/lead solders are commercially available with tin concentrations between 5% and 70% by weight .The greater the tin concentration, the greater the solder's tensile and shear strengths . At the retail level , the two most common alloys are 60/40 Sn/Pb and 63/37 Sn /Pb used principally in electrical work . The 63/37 ratio is notable in that it is a eutectic mixture .

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]

e.g .electronic lab devices, Home satellite ,solar cells[5] and life critical medical applications. The fumes produced from soldering operations are potentially dangerous. The process may generate a fume which is a combination of lead oxide (from lead based solder) and colophony (from the solder flux). Each of these constituents has been shown to be hazardous.

EXPERIMENTAL WORK

The elements (Sn ,Bi) melted to manufacturing the alloy were of high purity (99.99), melted in tube furnace under inert atmosphere. Two alloys were prepared for sake of comparison ,the first quenched in a hard cooled surface , wile the second was casted in well finished mold to produce the wire form of (Diameter 3mm)and of (length 130mm).

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 ,spectra obtained by using Ni-filtered Cuk α radiation ,λ=0.15418 nm ,operated at 40 KV and 20 mA .The scan range 2 degrees chosen between 10-50 degrees run at a scan of 0.2 deg./sec. ,while optical microscopy was used to characterize the microstructure feature .

RESULTS AND DISCUSSION

The x-ray diffraction results of the specimen after casting are given in figure (1) .In the thermal diffusion temperature range (200 – 300) C^0 , Sn is melted and the solution of Bi in the molten Sn is considered to take place forming Sn-Bi phase[9]. The thermal character was found in the Sn40-Bi60 binary composition .Figure (2) is a typical DSC profile of the alloy .As have been discontinues slope change on per melting portion of the heat extraction well ,the solder temperature of this -137 C^0 (Onset). The primary liquids temperature was -140 C^0 (Peak).[6]

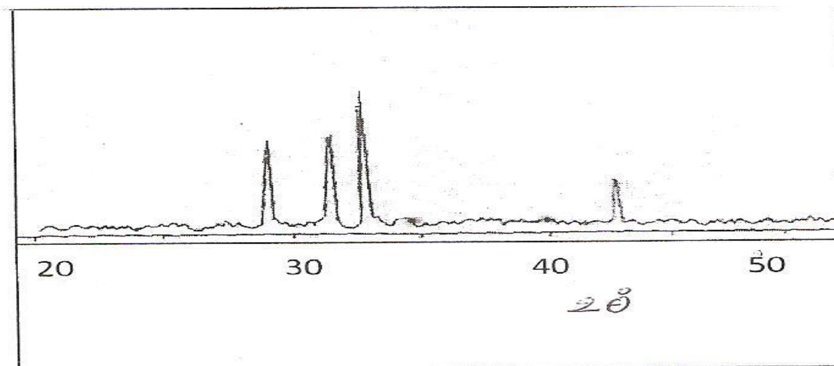


FIGURE 1. X-ray Diffraction Pattern of the Sn40-Bi60 alloy .

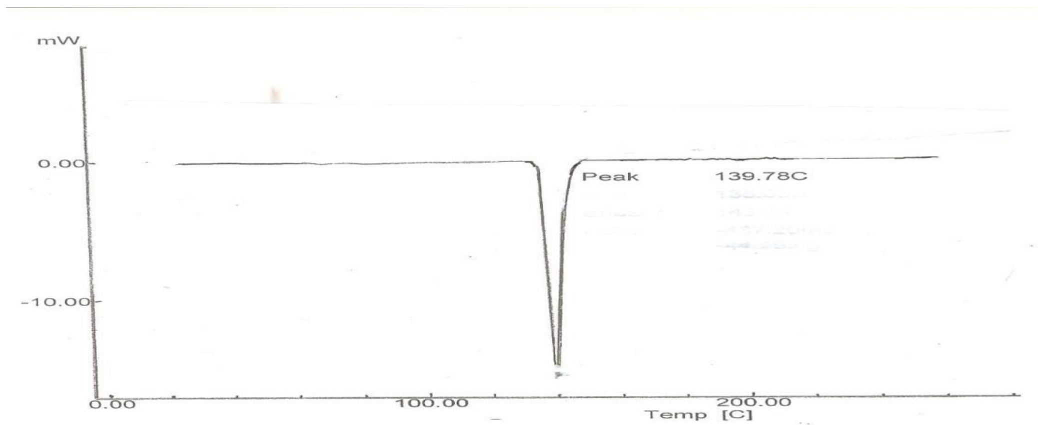
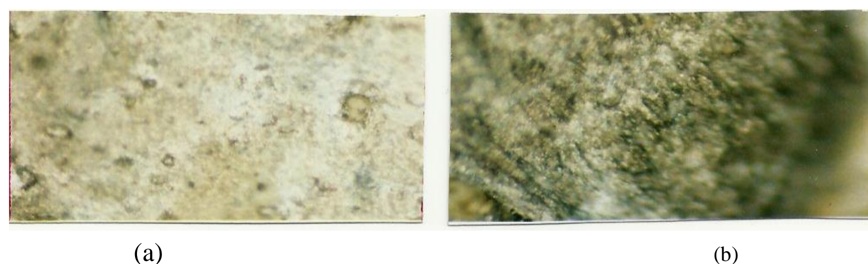


FIGURE 2. Typical Differential Scanning Calorimetric (DSC) profile for the Sn40-Bi60

The microstructure of the Sn_{40}-Bi_{60} alloy reveals the presence of the Sn-Bi eutectic alloy consisted of 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 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 (3b).



(a) (b)

FIGURE 3. Optical Micrographs, Sn40-Bi60 allo (a) as –cast microstructure (b) as- cast homogenize microstructure

The brinel hardness of value (2HRB) for the Sn_{40}-Bi_{60} alloy was obtained at room temperature it appears that the Harding of microstructure was caused by solid –solution of Bi into Sn-rich solid solution [(9)]

CONCLUSION

The melting point of the Sn_{40}-Bi_{60} alloy solder was found to be 137 C^0 . the microstructure change of Sn-Bi eutectic alloy solder was observed after completely melting and homogenization. It was found that the alloy of Pb- free solder having the softening hardness as solid- solution of Bi into Sn-rich solid solution of microstructure coarsening .And can be use as a very workable soldering alloy in electronic devices .

ACKNOWLEGMENT

The externally grateful to the all people that support , and facilities offered throughout this work , specially to the material staff department in the ministry of science and Technology .

REFERENCES

1- T. Yamamoto et al:"Assembly Technology Using Lead-free Solder ",FUSITSU Sci. Tech. s.,43,1,January 2007.

2- IPC-SN-786A,"Pocedures for characterizing and Handling of Moisturel, Reflow Sensitive", ICS (Linecoln wood , IL, 1995).

3- M.T.MC Cormack et al :"A lower –Melting-Point Solder Alloy for surface mounts, J. Jom 485,1996,pp.54-56.

4- C.s Ganeson and H.M.Bery , "Model and Analysis for Jolder Reflow Cracking Pheromenon in SMTplastic packages ", IEEE Trons, CHMT, G81993,PP.940-948.

5- Robert F .Mehl, "Metallurgy and Metallurgical Engineering Series ", New York and London 1942.

6- Mnyazawa , Y. Arige. T " Micro structural change and hardness lead free solder alloy", ECO Design apos; Firs, International symposium on volume , issume , 3-3 fob, 1999 , pp.616-619.

7- Massalssci T.B. "Binary Alloy Phase Digrams" ,American Society for metals ,Metals park ,Ohio ,1990 ,pp.3014-3017.

8- T.B.Massalski, H.Okamoto ,P.R. Subramanion and L. Kacprzak:, "Binary Alloy Phase Diagram "Second Edition (ASM) international, Materials park ,1990 ,PP.94-97.

9- M.Kitajima et al ,"Development of Sn-Zn-Al lead-free solder alloys ", FUSITSO Sci. Tech .J.,41.2,PP.225-235,2005.