SYNTHESIS OF BISMUTH – TIN ALLOYS BY ZONE MELTING METHOD

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ABSTRACT

In the present study, the zone melting method has been used to prepare bismuth – tin alloys successfully. Samples having different proportions of Bi and Sn were prepared and studied for their structural perfection. The experimental details of sample preparation and elemental analyses done using EDAX and other techniques are discussed in this paper. The structural studies were done using XRD.

Keywords: Bi, Sn, Edax, Xrd, Zone Melting.10 Bold Italic

I. INTRODUCTION

Lead (Pb) alloys were widely used as a soldering material, but the awareness of lead toxicity has greatly restricted its use in various applications making it necessary for researchers to search for alternate materials. The bismuth – tin alloy is believed to be a potential material to replace lead based alloys [1]. Several researchers [2, 3] have reported on the different properties of Bi-Sn alloys synthesized by various methods. In the present study, samples of Bi-Sn alloys were synthesized by the zone melting method. This method has been used to prepare materials of high purity (zone refining method) as well as to prepare homogeneous multicomponent systems, the zone leveling technique [4, 5]. The objective of the present paper is to prepare and study the effect of tin (Sn) concentration in the successful synthesis of Bi-Sn alloy.

II. EXPERIMENTAL DETAILS

The alloy samples were prepared in four different proportions by adjusting the weight of each element based on their molecular weights. To prepare the samples, AR grade bismuth and tin granules (~ 5 mm) were washed with 10% nitric acid, acetone and distilled water to remove surface oxide layers. Different weight proportions of both element were taken in quartz tubes (10 cm) which were evacuated at 8.2×10^{-4} m bar pressure and sealed. The sealed tubes were placed inside the zone melting apparatus consisting of transparent quartz tube, about a meter in length and having a diameter of 3 cm. A circular ring furnace mounted on a trolley was moved over this tube. The motion of the furnace was controlled by a series of pulley and gear mechanism. The sealed samples (charge) were placed at the center of the quartz tube. The furnace design was based on the nature of

the charge length to provide a charge to zone ratio of ten. The particular zone used had a width of half a centimeter giving a sharp variation of temperature on both sides of the charge. Stirring was done by vibration conveyed through the gear mechanism. Each samples were subjected to 10 molten passes along both the directions to ensure homogeneous distribution of both components. The zone speed was 3.33 mm/hr for all the passes. Each sample weighed about 52.245 g.

Transverse sections of the prepared Bi – Sn alloy ingots (Figure – 1) were cut using a saw blade and were mechanically polished.

Figure 1, Bi - Sn alloy ingot

The quantitative elemental analyses of the prepared samples were done using energy dispersive X – ray (EDAX) spectroscopy at room temperature, using JEOL JSM – 5610 LV Scanning Electron Microscope at an accelerating voltage of 15 kV in back scattered mode. The microstructural investigations were done using the same scanning electron microscope. The X – ray diffraction (XRD) data were collected on a Bruker D2 Phaser diffractometer with Ni filtered CuKα radiation ($\lambda = 1.5406\ A^0$). The applied voltage was 30 kV with a 10 mA current and the scans were performed with a step scan of 0.02^0. The range of 2θ was $20^0 – 60^0$ and the time per step was 0.1 s.

III. RESULTS AND DISCUSSION

The XRD patterns of the Bi – Sn samples having different percentage composition are shown in figure 2.

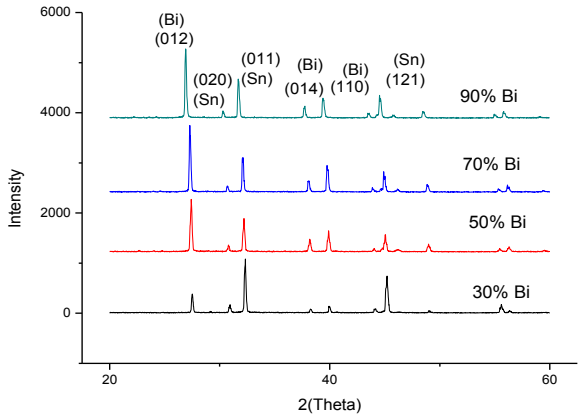

Figure 2, XRD Patterns of the Sample at Ambient Conditions

At ambient conditions, the diffraction patterns of the samples showed a mixture of two phases corresponding to Bi and Sn and the peak positions correspond very closely with those expected of the prepared samples. Existence of Bi and Sn phases were further confirmed by SEM micrograph and through EDAX.

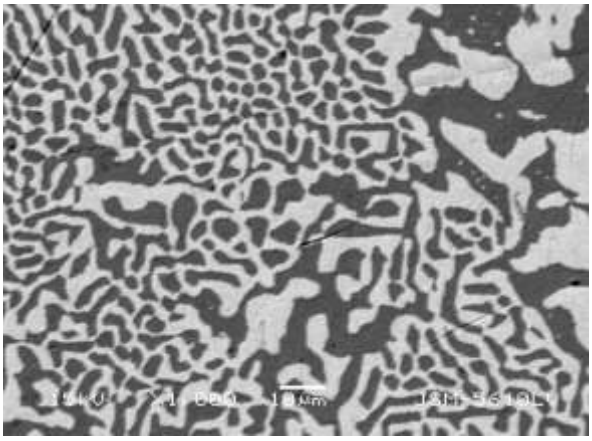

Figure 3, SEM Micrograph alloy cross section showing

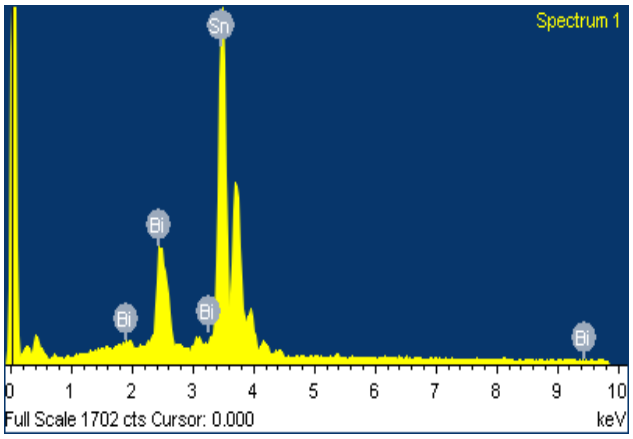

Figure 4, EDAX spectrumboth the Bi (white) and Sn (Grey) phases.

The XRD patterns shows a small shifting in the positions of peak with change in the proportion of Bi as well as changes in the intensity of reflections. The variation in the intensity of reflections are indicative of change in the texture of the samples and electron density distribution on increasing bismuth content. It is observed that with increasing concentration of Bi, the relative intensity of (012), (110), (104) and (022) reflections corresponding to Bi phase increases whereas that of (011), (020), (220) and (121) reflections corresponding to Sn decreases.

IV. CONCLUSION

Polycrystalline samples of Bi-Sn alloys were successfully synthesized by the zone melting method. The XRD patterns showed changes in the intensity of reflections as well as a small shifting in the positions of peaks. The anisotropic line broadening of the diffraction lines are due to heterogeneities and distortion of the unit cell and the presence of non-uniform strain in the prepared samples. Preparation of more samples of Bi – Sn alloys using the zone melting method and their structural characterization is to be carried out to understand the influence of growth parameters on the different properties.

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