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Development and characterization of lead-free Solders

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ABSTRACT

The paper describes about the replacement of Lead with a composite mixture – Al,Zn,Sn,In in the process of soldering to eliminate the null effects on the environment like soil pollution and air pollution. The Breaching of lead during the conventional soldering process causes the above effects. This has prompted the development of "Pb - free" solders with desired attributes of optimum melting point, wettability, Pasty range, Reduced Intermetallic layer and Ductile Nature. A number of tests have been conducted over the newly developed composite mixture, revealing reduced environmental effects when replaced with Lead without affecting the nature of the Process.

Keywords: *Soldering, Pollution, Composite Mixture, Pastry range, Ductile nature, Wetability.*

1. INTRODUCTION

The Main Objective of this Project is to develop a Composite Alloy and Compare its Microstructure, Thermal Properties and Hardness to ultimately find a replacement solder material other than Lead. This Replacement aims to eliminate the Toxic effects induced by Lead to the Surrounding Environment. At present, the use of Sn-Pb Solders has become indispensable due to their commercial uniqueness, hence the possible replacement Candidate should possess a number of Suitable Characteristics for effective replacement. The Most Popular Candidates for Replacing the Lead Containing Solder Alloys are – Sn-Cu, Sn- Ag, Sn-Ag-Cu, Sn-Bi, Sn-Zn, Bi-In-Sn Alloy Systems. Recent Research found Eutectic Composition of Sn-Zn solder alloy has more suitable Solder Properties due to its Low Melting Point, Excellent Mechanical Properties and low Cost. The Composite Material that we have choose is Al-Zn-In-Sn and have tested this composite for Hardness, Microstructure, and compared with Lead using SEM, Edax and DSC to Figure out the closeness of this composite with Iron for the replacement.

2. EXPERIMENTAL PROCEDURE

2.1 Sample Preparation

The Preparation is initiated by Characterizing the Microstructure or the features of the sample. The preparation begins by grinding the sample in water lubricated abrasive wheel. This is done to remove the surface damage that occurs during the sectioning and to provide a flat surface. This procedure includes a series of finer abrasive grains.
The polishing step in metallurgical sample preparation removes the last thin layer of the deformed metal for a smooth reflective surface. It leaves a sample for the examination of the unetched characteristics. The Final step that might be used is etching in an appropriate acidic or basic solution in order to the bring out the microstructure of the test sample.
The Molten Alloys were homogenized at 810 degrees Celsius for an hour in Alumina Crucible. A cooling rate of 6-8 degree Celsius per second.

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2.2 Microstructure Analysis

The specimens are prepared from the sample by cutting to the dimensions of 10x10mm and mirror polished with the presence of silver solution. The microstructures of the Sn-9Zn alloy simply consist of homogeneously dispersed fine precipitate of the Zn phase in the grey β-Sn matrix. On observing under microscope some locations a Zn rich phase and Al rich Phase has found a large amount of very fine precipitates but no distinct In rich phase was found, with addition of 2%Al and 2.5%In, the microstructure with a uniform distribution of Zn as a needle-shaped Zn rich phase and as a leaf shaped Al rich phase, former phase is effective in improving the strength of the solder joints. In some locations a Zn rich phase and Al rich phase has been found to form a large amount of very fine precipitates but no distinct In rich phase was found.

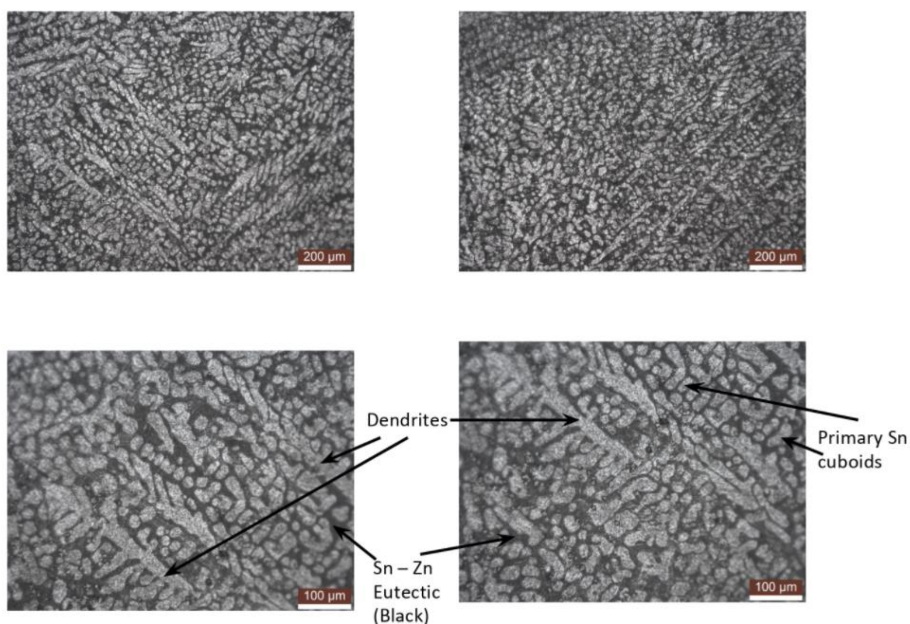
2.3 Mechanical testing

The hardness number for the composite is determined using Vickers hardness testing machine, three trials were taken from three different specimen species. The Heating process was done in a pit furnace with aluminum crucible at 800 degree Celsius for 1.30hr. Hardness test is done by a optical method. The Load is compreesed in ISO6507 pyramid identer. The load varies from 10 to 100 gram force.

3. RESULTS

3.1 Optical Microscopy

Microstructure consists of eutectic type of microstructure. Many regions with Dendritic structure is cooled through directional solidification. Primary dendrites as well as secondary dendrites are observed. Consists of Primary Tin Cuboids at many regions.



3.2 X-ray Diffraction (XRD)

The composite mixture of the various alloys was assessed by E-Dax. Its used to identify the various phase identifications. The materials are grounded. It tends to be homogenous. Bulk Composition can be attained.

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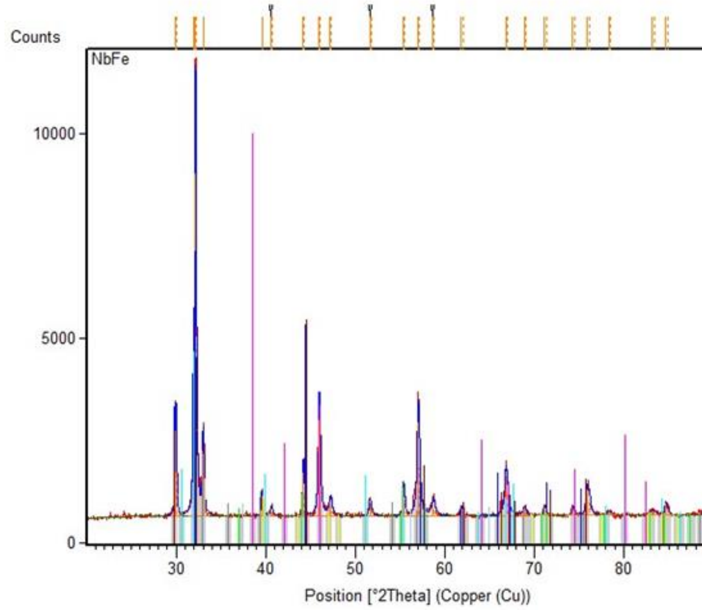
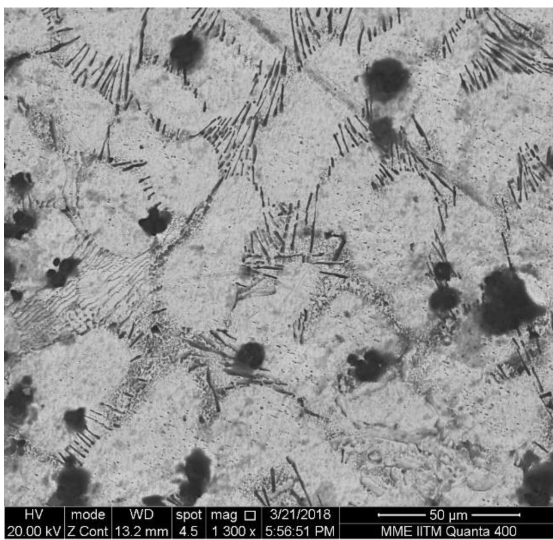
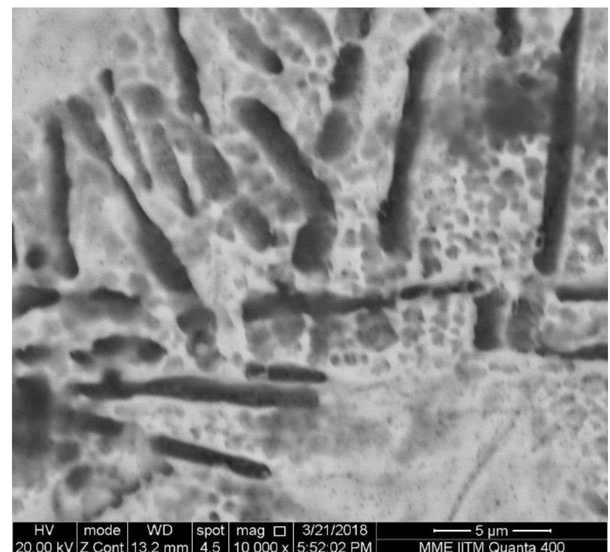


3.3 Scanning Electron Microscope

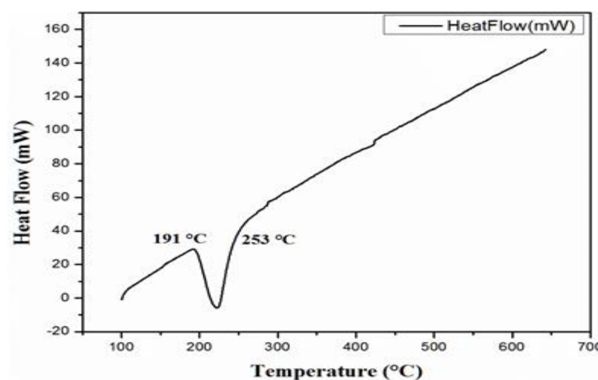
SEM produces an image through scanning a surface. Various signals can be produced like secondary electrons[SE] and black scattered electrons [BSE] It consists of yield characteristics due to 3-dimensional appearences.





3.4 DSC Curve:

The DSC curve shows the temperature along with the heat flow. It shows the addition of alluminium to the Sn-Zn alloy. The curve shows the endothermic peak Tm. IT increases at every stage. The addition of alluminium to the Sn-9Zn alloy affects the melting temperature



4. CONCLUSION

This project has developed a new solder alloy and investigated the influence of adding small amount of Aluminum and Indium on the microstructure, Thermal Properties of Sn-9Zn based lead free alloy. Addition of aluminum and indium tends to suppress the Zn phase from the solid matrix.

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