

UNIVERSITI TEKNOLOGI MARA

**INTERMETALLIC AND LEACHING
STUDY OF (Sn-8Zn-3Bi)-1Ag LEAD-
FREE SOLDER**

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ABSTRACT

Due to the health concerns, the demand for Pb-free solder is greater than before. In the past, Sn-Pb solders were widely used in soldering process due to their excellent soldering characteristics and reliability. Pb-free solder, the Sn-8Zn-3Bi eutectic alloy is regarded as one of the best potential candidates. This study investigated the effect of silver (Ag) addition on morphology, growth rate of Cu_5Zn_8 , Cu_6Sn_5 and Cu_3Sn intermetallics in the Sn-8Zn-3Bi solder. Besides that, leaching activities of heavy metal from solder alloys are also observed. Firstly, when the mixing process occurred, the addition of Ag into the Sn-8Zn-3Bi solder has increased the melting temperature from 202°C to 228.19°C . After that, the reflow was done at 220°C , 230°C , 250°C , 270°C and 290°C at various soldering times. The Sn-8Zn-3Bi solder reacting with Cu substrate formed a single Cu_5Zn_8 intermetallic layer with a flat structure. On the other hand, the reaction between (Sn-8Zn-3Bi)-1Ag solder and Cu substrate produces Cu_6Sn_5 and Cu_3Sn intermetallic and both intermetallic has a scallop structure. The thickness of the intermetallics increases with aging temperatures and time. The addition of Ag into the Sn-8Zn-3Bi solder has significantly suppressed the formation of Cu_5Zn_8 intermetallic, and promoted the growth of Cu_6Sn_5 and Cu_3Sn intermetallic. Growth rate constant of Cu_5Zn_8 phase is lower at low temperature and increase at high temperature, but only before the addition of Ag into solder system. Meanwhile the growth rate constant of Cu_6Sn_5 is bigger than Cu_3Sn phase, thus providing an opportunity for Cu_6Sn_5 phase to predominate the total intermetallic compounds in this liquid-state aging study. Activation energy obtains for Cu_5Zn_8 phase was 78.54kJ/mol meanwhile for Cu_6Sn_5 and Cu_3Sn phase is 266.72kJ/mol and 27.14kJ/mol each. In leaching of heavy metals, Sn was detected as the most leached heavy metals from solder alloy followed by Zn element. In this leaching process electrochemical and galvanic reaction contributes to the corrosion process that occurs in the bulk solder and solder joint.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

In current situation of everyday living, the use of electronics in industry as well as personal use has been growing vigorously. One of the preferences is the microelectronics industry, which has been using Pb-Sn solders for a variety of interconnection needs, practically from its inception. However, a restriction towards environmental awareness has become the main highlight in this new era of technologies especially microelectronics industry. In this specific intense, traditional lead-based body solders have been the choice of restorers and customizers for over 80 years. It is widely used in the electronic industries because of their unique properties and low cost (Yu, Zhao, & Wang, 2004). Sn-Pb solders is one of the selections of leaded solder that is widely used in soldering process and electronic products due to their excellent soldering characteristics and reliability. It has good solder ability, wetting properties and ability to absorb strain without hardening and cracking. The Sn-37Pb solder as an example has been more easy and convenient to use and has been regarded as the “grand champion of soldiers.” Sn-37Pb alloys also are the dominant solder used widely in manufacturing because of their special characteristics (Choi, Bieler, Lucas, & Subramaniam, 1999).

On the contrary, the development of lead-free solders has been an indispensable and urgent task in the electronics manufacturing because of the limitations. This has motivated the development of lead-free solders, and has enhanced the research activities in this area. There is an issue within this situation that needs to be addressed significantly. Most specifically consumer products (i.e. computers, hand phones) are considered disposable because of the introduction of newer faster technologies each year. In fact, these disposed devices generally end up in landfills. Accordingly, to the health concerns, the demand for improved solder is greater than before. At the same time, a concern that lead and other materials