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INTERMETALLIC THICKNESS AND PHYSICAL STUDIES OF Sn-3.5Ag-1.0Cu LEAD FREE SOLDER WITH Ni ADDITION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged or referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Due to the environmental and health concern, the use of lead free solder has been introduced in 2000 by National Electronics Manufacturing Initiative (NEMI) to replace the tin-lead (Sn-Pb) solder. Among many lead free solders, the tin-silver-copper (Sn-3.5Ag-1.0Cu) is a potential replacement for Sn-Pb because it has a good compatibility with common commercial components and low melting point compared with other lead free solders. This research was carried out to study the properties of Sn-3.5Ag-1.0Cu solder by adding three different amount of Ni into the solder which was characterized for its melting temperature, density and hardness test. The melted solder was aged in an oven until 1000 h for intermetallic and joint strength study. Intermetallic formation was analyzed under the Scanning Electron Microscope (SEM) and Energy Dispersive X-ray (EDX). Shear joint sample was tested using an instron machine. The onset temperature slightly increases to 220.3°C and liquidus temperature and pasty range decrease to 233.6°C and 13.3°C. 2 h mixing time and 14 MPa pressure are an optimum condition for sample preparation. The addition of Ni retards the growth of intermetallic with 0.05 wt.% Ni the most significant value compared to 0.2 and 0.5 wt.% Ni. 0.05 and 0.2 wt.% Ni give the smallest and similar total growth rate constant (*k*) which is 10.240×10^{-14} cm^2/s. Smallest growth rate values indicate the smallest diffusion coefficient reaction between solder and substrate during aging process, retards the intermetallic thickness which influence solder joint strength. Stress and strain values increase with the decreasing of intermetallic thickness. 0.05 wt.% Ni has the highest stress and strain values which are 21.52 MPa and 0.118.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Solder interconnects perform three major functions that were electrical, mechanical joining and thermal for electronic packaging. It has been existence in the last few decades in electronics industry and they provide the electrical connection path from silicon chip to the circuitry on the substrate [1]. Solder becomes important in the electronics industry due to the recent technology. Despite this challenge, most researchers from universities and industries have largely overlooked the type of alloying elements used to produce a good solder as a connecting material for electronic devices.

In electronic packaging industries, the main element of solder materials used is tin (Sn). From the very beginning of the electronics industry, solder joints have been made primarily of alloys of tin and lead [1, 2]. The eutectic Sn-37Pb solder was widely used in the electronics industry due to its outstanding solderability and reliability [3]. These factors make the Sn-37Pb solder as ideal and is extensively used as soldering material in the electronics industry [4].

However the use of lead in solder is toxic and harmful to the environment and human health [5]. According to Schneider et al., [6] lead is potentially dangerous for humans, infants and very young children as they are particularly vulnerable to the neurotoxic effects of this metal. The increasing of electronic waste, most of which ends up in landfills has become a more serious issue because the Pb ion (Pb^{2+}) from electronic devices will become toxic in water. The solder that contains Pb when thrown in landfill will contaminate the ground water [7]. The Pb also contaminates the drinking water system from acid rain and absorb onto the surface and into the ground water.

Due to the environmental issue, the recycling of solder was used as one of the solutions. However, the high cost of recycling process makes the recycling rate of electronic devices very low and the used electronic ends up in landfills [3]. Pending Legislation and Environmental Protection Agency Regulations would have to against take an action the toxicity of Pb issue. Since the beginning of the 90s, the removal of