Intermetallic Growth and Shear Strength of SAC305/Electroless Nickel Boron

Abstract

Purpose – The paper aimed to study the effect of aging and cooling rate on the reliability of the solder joint using electroless nickel boron (EN-Boron) as a surface finish in the electronic packaging area.
Design/methodology/approach – EN-Boron was plated on Cu substrate through electroless plating method. This process was followed by reflow soldering of a Sn-3.0Ag-0.5Cu solder alloy on metallized Cu substrate to form a joining. Then, the specimens were cooled using different cooling medium which were air (slow cooling) with 15.7°C/min and water (fast cooling) with 110.5°C/min. After that, the specimens were subjected to isothermal aging at 150℃ for 0, 250, and 1000 hours. Finally, they went through a lap shear test following a standard of ASTM D1002. Optical microscope and SEM were used for IMC characterization. The type of IMC formed was confirmed by FESEM-EDX.
Findings – The results showed that the IMC type changed from the combination of Ni_3Sn_4 and $(Ni,Cu)_3Sn_4$ after reflow soldering into fully $(Ni,Cu)_3Sn_4$ when aged for 1000 hours. The formation of $(Ni,Cu)_3Sn_4$ and Cu_3Sn underneath the IMC layer played a role in reducing the shear strength of joining. Overall, water cooling was reported to provide higher shear strength of solder joint compared to air cooling medium.
Originality/value – The shear strength between solder alloy and EN-Boron surface finish is comparable to the surface finish conventionally used.

Keywords—*Boron plating, cooling rate, aging, intermetallic compound, shear strength, and grain structure.*

INTRODUCTION

Rapid development in technology has been a great challenge for the electronic industry to keep up with the industrial requirement to provide a cost-effective smart devices which at the same time maintaining its quality. The quality of electronic packaging is directly related to the solder joint which turn out to be the main concern in the electronic industry. A few components are involved in ensuring a formation of good solder joint including the type of surface finish used. Surface finish does not only work as a coating layer to protect the electronic board (copper board) but it also acts as a diffusion barrier layer to inhibit excessive diffusion between Cu substrate and solder alloy. Even though the intermetallic compound (IMC) is important because it can determine the strength, ductility, density, conductivity, and crystal structure of the solder joint, but excessive IMC growth can be detrimental to the whole package due to its brittleness in nature. According to the previous studies, (Bernasko et al., 2015, Wei et al., 2011, Nakamura et al., 1998, Grossmann et al., 2005), they mentioned that the Cu atom will diffused towards solder alloy and form IMC during reflow soldering. Therefore, another layer is needed on top of it to prevent excessive diffusion of Cu,. The added layer acts as a barrier and prevents Cu from diffusing (from Cu substrate) into the solder alloy and thus producing a thin IMC layer (1.5 μm–4 μm). Thin IMC layer is needed to achieve a good metallurgical bonding (Pan et al., 2009).

Currently, nickel-based metallization favours the electronics packaging market since it can prevent excessive IMC formation during packaging and in service condition (Ghosh, 2000). The low cost and simple process make nickel a special candidate to act as a diffusion barrier layer between Cu and Sn in order to inhibit the dissolution of under bump metallization on flip chips (Kumar, 2005). Recently, nickel-boron deposits have wider application in the coating sector due to its superior properties in terms of hardness, wear resistance, and electrical conductivity. The nickel-boron surface finish is also