**The effect of nickel doping on SAC305 lead-free solders and EN(B)EPIG surface finish**


ABSTRACT

Recently, there are many portable electronics product such as i-pad, smart phone and tablet were widely used due to growing needs of busy lives and demanding, more functionalities and compatibility. The growing of these smart technologies made electronic packaging are moving parallel with current technology and expanding rapidly because of global competitive pressure. Thus, flip chip technology is one of the important element need to be considered in order to produce high performance and quality of electronic devices due to shorter electrical connections between the chip and substrate and very high input/output capacity and the smallest possible package size. In flip chip applications, solder bump was used to connect the die to the substrate or circuit board. The addition of doping element in lead-free solder has been discussed have a big influence on the solder joint quality including solder microstructure. It also can enhanced the properties and improve the performance of interfacial reaction at interface and made a reliability of lead-free solder especially on Sn-3.0Ag-0.5Cu was increased. Therefore, this study investigates the effect of nickel doping on Sn-3.0Ag-0.5Cu (SAC305) lead-free solders and electroless nickel (boron)/electroless palladium/immersion gold (EN(B)EPIG) surface finish. In this study, two types of lead-free solders was used which are Sn-3.0Ag-0.5Cu (SAC305) and Sn-3.0Ag-0.5Cu-0.05Ni (SACN30505) with solder size diameter of 500 εm in order to examine the effect of nickel on interfacial reaction during soldering process. Reliability of solder joint has been assessed by performing solid state isothermal aging at 125C for 250, 500, 1000 and 2000 hours. Several characterization techniques will be conducted including image analyzer, optical microscope, field emission scanning electron microscopy and energy dispersive x-ray analysis to characterize the intermetallic formed. After reflow soldering process, it was found that the (Cu, Ni)6Sn5 and (Ni, Cu)3Sn4 intermetallic compound (IMC) is formed at interface. (Ni, Cu)3Sn4 dominates in the outside of solder joint while (Cu, Ni)6Sn5 dominates in the centre of joints. Besides that, after soldering and isothermal aging process, SAC305 solder with additions of 0.05% of Ni (SACN30505) made the intermetallics grew slightly faster than in the solder without Ni additions. Hence, analysis by optical microscope revealed that the IMC thickness of the SACN30505 solder produced thicker IMC compared to SAC305 for both situations. This observation is confirmed by the increase in grain size of intermetallics with Ni additions. Moreover, aging time resulted in an increase in thickness and changed the morphology into more spherical, dense and large grain size. In addition, the results also revealed that the thickness of intermetallics formed is proportional to the aging duration.



**Keyword:** Nickel doping; Lead-free solders; SAC305; Soldering; Flip chip applications