中文摘要

探討Sn-Ag-Cu 無鉛銲料與Au/Ni 基板表面處理層(surface finish)之間的反應是非常複雜的。因為其中包含了（1）不同的銲錫球球徑760、500、300 微米（2）搭配著不同孔徑的銲墊600、425、250 微米（3）銲墊上方不同厚度的Au 表面處理層0、0.6、3 微米（4）不同的銲錫球組成Sn-3Ag-xCu，X= 0.3 ~ 0.7（5）兩種迴銲時間，共五大類的變因。

本研究的結果顯示，工業界慣用的銲料與基板在銲接過程中，銲料所具有的Cu 濃度，依然是左右界面反應的重要角色。即使微量改變銲料的Cu 濃度，將會使界面上呈現不同的介金屬種類與生長型態。當Cu 濃度由0.3 wt.%逐漸增加至0.7 wt.%,迴銲後界面生成物與型態將由單一的Ni3Sn4 相,轉變為Ni3Sn4 與Cu6Sn5 共存，再轉變為單一的Cu6Sn5 相。Cu 些微改變，界面反應截然不同。

銲墊上Au/Ni 表面處理層的Au 厚度也對銲接反應有重要的影響。當Au 表面處理層厚度為3 微米時，造成Sn-3Ag-0.4Cu 反應界面，產生大量Cu6Sn5 相介金屬剝離情形，此現象於三種不同大小的銲錫球與銲墊搭配均會發生，且不論反應時間為90 或300 秒。由此可見，過厚的Au 層將會造成介金屬脫離界面，並間接使得銲點可靠度發生問題。

值得一提的是，即使銲墊上方Au 層厚度薄如0.6 微米，也會使得直徑300微米

的銲錫球，於90 秒迴銲後，界面處介金屬中產生許多清晰可見的孔洞。這些孔洞被銲料所填滿，並隨著反應時間增長而變大。相信只要施以足夠的反應時間，孔洞上方的介金屬層也會完全脫離界面而進入銲料內部。

上述結果顯示，介金屬剝離的現象會隨著Au 層厚度的增加而趨於嚴重。且隨著銲點縮小，即便Au 層厚度保持不變，也會使得銲料中具有相對較高的Au濃度，Au 濃度越高越容易致使介金屬剝離。因此由本實驗結果可以得知，為了確保銲點的品質，對於銲料組成的選擇，以及Au 表面處理層厚度的控制應該要非常謹慎。為了避免此介金屬剝離現象的發生，銲接反應時應注意（1）盡量使用Au 層厚度較薄的表面處理層，（2）盡量選用Cu 濃度較高的銲料，避開剝離反應發生的區間，（3）以最短但容許範圍內的迴銲時間進行迴銲。

Abstract

The soldering reactions between the Au/Ni surface finish and severalSn-3Ag-xCu (x= 0.3, 0.4, 0.5, 0.6, and 0.7 wt. %) solders were investigated. Thevaried volume of the solder balls with 760, 500 and 300 μm diameter were used onthe 0, 0.6 and 3 μm thick Au lay having a circular area with 600, 425 and 250 μm. Itwas found that interfacial reactions were controlled by a number of factors, includingthe concentration of Au and Cu, the reflow time, and paired the solder volume andpad area. With increasing Cu concentration, the reaction product at the interface switched from Ni_3Sn_4-based to Cu_6Sn_5-based + Ni_3Sn_4-based, then to Cu_6Sn_5-based.

In addition, the Au thickness was found to have a strong influence on the microstructures of the reaction products. After Sn-3Ag-0.4Cu solder ball reflowed on a 3 μm Au layer at 235°C for 90 sec, a Cu_6Sn_5-based layer had departed from the solder/pad interface and moved towards the solder joint. In addition, a layer of solder located between detached Cu_6Sn_5-based and adhered Ni_3Sn_4-based layer. Similar phenomenon occurred on smaller size of solder as 500 and 300 μm. It deserved to be mentioned that even 0.6 μm-thick Au layer can cause a series voids formed between $(Ni, Cu)_3Sn_4$ and $(Cu, Ni, Au)_6Sn_5$ layers at the interface. Due to production of Au concentration had been raised over an unsafe level. These voids indeed weaken the Sn-3Ag-0.4Cu solder joints and lead serious reliability problem further. As the device size shrinks, precise control of solder composition and thickness of surface finish should be more critical.