摘 要

在全球環保意識抬頭綠色化影響之下，加上歐盟在其 RoHS 指令中明確要求在 2006 年 7 月起，任何於歐洲銷售之電子產品皆不可含有鉛、鎘等有害物質，故未來電子產品無鉛化勢在必行。

本論文乃探討無鉛銲料與 Pt、Cu 基材間之界面反應，欲了解以 Pt 墊層取代原先之 Au/Ni 表面處理層之界面反應。本論文將報導 SnAg-Cu 銲料中銅濃度變化對於銲料與 Pt 基材介面反應之影響，觀察界面生成物之種類、微結構以及形態變化；此外，為了解 Pt、Cu 間之交互作用，另以 SnAg-Pt 銲料與 Cu 基材進行反應作為對照組，以利分析。

第一部份實驗選用 Sn3Ag 和 Sn3Ag0.5Cu 分別與 Pt 基材進行界面反應，由固/液反應以及固/固反應之實驗結果可觀察到界面皆生成一層連續之 $PtSn_4$ 介金屬。然而固/固反應時，發現在 SnAg 銲料中添加適量的 Cu 元素可有效的抑制界面 $PtSn_4$ 介金屬之生長。

第二部份實驗選用 Sn3.5Ag-xCu 銲料，(其中 x =2、5 及 10 (wt.%))。研究發現固/固反應時，銲料中 Cu 濃度介於 2-10 wt.%範圍時，Cu 濃度對於抑制 $PtSn_4$ 介金屬之生長效果並無明顯差異，但仍優於銲料中 Cu 濃度為 0.5 wt.%時之抑制效果。此外，當熱處理時間拉長至 2000 小時時，銲料內之化合物 Cu_6Sn_5 與 Ag_3Sn 已回到界面形成一層連續層覆蓋在 $PtSn_4$ 上。

另外一組對照組選用 Sn3.5Ag-yPt 銲料，其中 y 分別為 0.5、1 及 3(wt.%)，與 Cu 基材進行界面反應。有趣的是，在液態中，隨著 Pt 濃度的增加，界面介金屬 Cu_6Sn_5 之微結構有顯著的差異，分別有層狀、圓形、柱狀以及扇貝狀的形態。

上述之研究結果中得知在 SnAgCu/Pt 亦或 SnAgPt/Cu 系統中，依 EPMA

偵測反應生成物 $PtSn_4$ 與 Cu_6Sn_5 化合物鑑定之結果得知：$PtSn_4$ 內未偵測到 Cu 之訊號，於 Cu_6Sn_5 內亦無 Pt 之訊號，故 Pt-Sn 系統及 Cu-Sn 系統的二元反應是獨立的，Pt 與 Cu 無交互影響、無交互作用。

若欲以 Pt 取代 Au/Ni 表面處理層，需具有良好之潤濕性。故測試 Pt 與 SnAg0.5Cu 無鉛銲料間之潤濕性質，取 Ni 基材作為對照組。整體而言，使用 RMA 助銲劑時，Pt、Ni 基材之潤濕性質皆優於水溶性助銲劑；就 Pt、Ni 之潤濕性質而言，Ni 之潤濕性稍優於 Pt。但 Pt 之潤濕性仍在可接受的範圍內。

Abstract

Au/Ni is the most common surface finishes for Cu soldering pads in ball-grid-array (BGA) and other electronic packages. The Au layer is for oxidation protection, and the Ni layer serves as a solderable diffusion barrier. Platinum also has good properties for a wetting layer. Because platinum has a lower dissolution rate than nickel and good resistance to oxidation, gold is not needed for oxidation protection.

The object of this investigation is to study interaction between Sn-rich solder contain a small amount of copper and platinum and copper substrate. Firstly, Sn-3Ag, Sn-3Ag-0.5Cu were reacted with platinum by typical reflow process at a peak reflow temperature of 235 ℃. After reflow, a continuous intermetallics layer formed at the solder/platinum interface. Comparing the interfacial reaction of the Sn-3Ag system with the Sn-3Ag-0.5Cu system, Sn-Ag solders contain a small amount copper can suppress the consumption rate of platinum effectively.

Secondly, Sn-3.5Ag-xCu (x = 2,5, and 10 wt.%) were reacted with platinum by reflow at 250 ℃. After aging, the consumption rate of platinum of the concentration of copper between 2-10 wt.% is slower than the concentration of copper is 0.5 wt.%. The extents of suppressing the growth rate of $PtSn_4$ for the cases with Cu concentration from 2 to 10 wt% are almost the same. After 2000 h aging, a continuous IMCs layer formed and covered in the $PtSn_4$. Thirdly, Sn-3.5Ag-yPt (y = 0.5,1, and 3 wt.%) were reacted with copper by reflow at 250 ℃. In the liquid reaction, the morphology of Cu_6Sn_5 depended on the composition of platinum in the solder.

However, the result of EPMA analysis showed that the copper signal can not

be detected in the $PtSn_4$ intermetallic compound and the platinum signal can not be detected in the Cu_6Sn_5 intermetallic compound in the SnAgCu/Pt and SnAgPt/Cu system. On the other word, the binary reaction of Pt-Sn system and Cu-Sn system is independent. There is no interaction between Pt and Cu.

Finally, wetting properties of Sn-3Ag-0.5Cu on Pt and Ni substrates at 240 °C were determined by using a wetting balance technique. In the analysis of wetting time, the wettability of Pt was close to Ni.