中 文 摘 要

在銲接過程當中，擴散阻障層扮演著一個相當重要的角色，它的功用主要是防止銲料與 Cu 層快速反應，除了低消耗速率的 Ni 以及 Pt 之外，NiCu 合金是未來有可能用來使用的擴散阻障層之一。之前本實驗室的何政恩學長探討了錫銀銅無鉛銲料與 Ni 基材的液態反應，發現銲料中添加微量的 Cu 可大幅降低 Ni 基材的消耗，另外界面所生成的介金屬型態也會隨著銲料中 Cu 濃度不同而有所改變。

而本論文則是利用電鍍方式，在 Cu 層上電鍍 NiCu 合金作為擴散阻障層，並探討不同濃度的鍍層與 Sn3Ag 銲料間的反應情形。除了液態反應之外，本研究也深入探討固態反應時的反應行為，由結果發現當 Cu 濃度改變時，將會改變界面生成物的種類、型態以及反應過程的消耗行為。

本研究所採用的 NiCu 合金濃度為 Ni-15 at.%Cu、Ni-40 at.%Cu、Ni-54 at.%Cu，另外也做了純 Cu、純 Ni 作為比較組。在 120 sec 液態反應實驗中發現當鍍層為 Ni-15 at.%Cu、Ni-40 at.%Cu 時，與銲料反應後所生成的介金屬為$(Ni_{1-x}Cu_x)_3Sn_4$；鍍層為 Ni-54 at.%Cu 時，所生成的介金屬為$(Ni_{1-x}Cu_x)_3Sn_4$、$(Cu_{1-x}Ni_x)_6Sn_5$兩相共存；另外純 Ni 與銲料反應生成 Ni_3Sn_4；純 Cu 則生成 Cu_6Sn_5。在固態反應實驗中發現隨著熱處理溫度的增高以及時間的增長，鍍層為 Ni-15 at.%Cu 時界面的介金屬依然只以$(Ni_{1-x}Cu_x)_3Sn_4$存在；鍍層為 Ni-40 at.%Cu 時所生成的介金屬為$(Ni_{1-x}Cu_x)_3Sn_4$以及$(Cu_{1-x}Ni_x)_6Sn_5$兩相共存；然而鍍層為 Ni-54 at.%Cu 時介金屬則是以$(Cu_{1-x}Ni_x)_6Sn_5$為主。

在 120 sec 液態反應後發現，NiCu 合金的消耗隨著 Cu 濃度的增加而增加；300 sec 液態反應後，NiCu 合金的消耗隨著 Cu 濃度的

增加而增加，然而令人意外的是 Ni-54 at.%Cu 的消耗會比純 Cu 還快。而且在固態反應之後 Ni-40 at.%Cu 、Ni-54 at.%Cu 的消耗均會比純 Cu 還快。

由本研究結果發現，在電鍍液當中添加少量的硫酸銅，便會讓鍍層的 Cu 含量大幅提升，並使 NiCu 合金的消耗、界面的介金屬種類以及型態大幅的改變。

ABSTRACT

Diffusion barrier plays an important role in soldering, it can prevent fast reaction between tin and copper. Beside nickel and platinum, nickel-copper alloy is a possible diffusion barrier in the future. In the past, our labortoary investigated liquid/solid reaction between SnAgCu solder and nickel, it found that little copper added in solder can reduce consumption of nickel. Additionally, intermetallic compound at interface can also changed with copper added in solder.

In the experiment, we electroplated nickel-copper alloy on copper and investigated reaction between Sn3Ag solder and different concentration nickel-copper alloy. Beside liquid/solid reaction, we also investigated solid/solid reaction. According to the result, change of concentration in nickel-copper alloy will affect intermetallic compound phase and consumption.

Beside copper and nickel, we also electroplated Ni-15 at.%Cu ,Ni-40 at.%Cu and Ni-54 at.%Cu. After 120 sec liquid/solid reaction, intermetallic compound between tin and Ni-15 at.%Cu is $(Ni_{1-x}Cu_x)_3Sn_4$；intermetallic compound between tin and Ni-40 at.%Cu is $(Ni_{1-x}Cu_x)_3Sn_4$；intermetallic compound between tin and Ni-54 at.%Cu is $(Ni_{1-x}Cu_x)_3Sn_4$ and $(Cu_{1-x}Ni_x)_6Sn_5$.After solid/solid reaction, intermetallic compound between tin and Ni-15 at.%Cu is $(Ni_{1-x}Cu_x)_3Sn_4$；intermetallic compound between tin and Ni-40 at.%Cu is $(Ni_{1-x}Cu_x)_3Sn_4$ and $(Cu_{1-x}Ni_x)_6Sn_5$；main intermetallic compound between tin and Ni-54 at.%Cu is $(Cu_{1-x}Ni_x)_6Sn_5$.

After 120 sec liquid/solid reaction, consumption of nickel-copper alloy will increase with copper concentration in alloy. Surprisingly, consumption of Ni-54 at.%Cu is faster than copper after 300 sec liquid-state reaction. After solid/solid reaction, consumption of Ni-40

at.%Cu and Ni-54 at.%Cu is even faster than copper.

In the research, we found that a little sulfur copper added in electrolyte will great affect copper concentration in nickel-copper alloy, intermetallic compound phase and consumption.