Available online at www.sciencedirect.com
ScienceDirect
Microelectronic Engineering 84 (2007) 2653–2657
MICROELECTRONIC ENGINEERING
www.elsevier.com/locate/mee

Effects of nodule treatment of rolled copper on the mechanical properties of the flexible copper-clad laminate

Chang-Yong Lee [a], Jae-Hong Lee [a], Don-Hyun Choi [a], Hoo-Jeong Lee [a], Hyoung-Sub Kim [a], Seung-Boo Jung [a,*], Won-Chul Moon [b]

[a] *School of Advanced Materials Science & Engineering, Sungkyunkwan University, 300 Cheoncheon-dong, Jangan-gu, Suwon 440-746, South Korea*
[b] *Micro Electronic Packaging Consortium, Sungkyunkwan University 300 Cheoncheon-dong, Jangan-gu, Suwon 440-746, South Korea*

Received 15 May 2007; accepted 21 May 2007
Available online 8 June 2007

Abstract

Rolled copper foil of 18 μm thickness underwent nodule treatment via electro plating in a solution containing dissolved $CuSO_4$ and $NiSO_4$. The product formed on the surface of the copper foil varied from copper oxides to nickel compounds of the sphere type with increasing current density and plating time. The highest surface roughness and maximum peel strength of 680 gf/cm were obtained with the formation of nickel compounds at a current density of 1.5 A/dm^2 and plating time of 30 s. In addition, the fracture location varied according to the plating parameters and occurred at the interface between the polyimide film and adhesive layer at the condition of the maximum adhesion strength.
© 2007 Published by Elsevier B.V.

Keywords: Flexible copper clad laminate; Rolled copper; Nodule treatment; Peel strength

1. Introduction

Flexible copper-clad laminate (FCCL) is a system which unifies an electric conductor such as copper and an insulator such as polyimide (PI). FCCL is generally employed as a raw material for flexible printed circuit (FPC). The electro-plated copper foils have usually been used as the conductive material in conventional rigid PCB. These days, however, the application of rolled annealed copper has increased in various electronics where its superior movable function is specially required instead of electro-plated copper such as in mobile phone application [1,2]. Generally, FCCL using rolled annealed copper suffers the problem of poor electronic quality due to insufficient adhesion between copper foil and polymer film because of the shiny and even surface of the copper foil. Thus, various studies have been conducted to improve the adhesion between rolled copper and polymer [3–6].

The adhesion between metal and polymer is affected by the synthetic affection of the composition, thickness, and surface roughness, of which the composition of the metal is the key parameter. Therefore, when chrome with a good interaction with polymer was employed as the interfacial layer, adhesion between copper and polymer could be improved, as has been reported in many related research papers [7,8].

In this study, an adhesive type FCCL was manufactured and copper and Ni nodule treatment was conducted on the copper surface by electro plating for adhesion improvement. The potential of electro-plated nickel as the interfacial layer was evaluated. The variation of composition, morphology and surface roughness of the plating layer with current density and plating time was investigated. In addition, the relationships between these parameters and the mechanical property were investigated.

* Corresponding author. Tel.: +82 31 290 7359; fax: +82 31 290 7371.
E-mail address: sbjung@skku.ac.kr (S.-B. Jung).

0167-9317/$ - see front matter © 2007 Published by Elsevier B.V.
doi:10.1016/j.mee.2007.05.063

2. Experimental procedure

The starting material was a rolled annealed copper of 18 μm thickness. After surface contaminants and natural oxides were removed using chloroform and diluted hydrochloric acid, the copper foil underwent nodule treatment by copper, nickel electro-plating in a solution with $CuSO_4$ and $NiSO_4$ as the main elements. To investigate the effects of the surface morphology on the adhesion property between copper foil and polymer, the current density and plating time were varied from 1.0 to 1.5 A/dm^2 and from 30 s to 60 s, respectively. Scanning electron microscopy (SEM) was used to observe the surface morphology and phase analysis of plating product with the applied parameters was carried out by energy dispersive spectrometer (EDS) and X-ray photoelectron spectroscopy (XPS).

The PI film used as the insulation material was kapton 100 H at 25 μm thickness. The PI type adhesive was coated on the PI film by knife type applicator and dried in a hot oven at a temperature of 473 K for 7.2 ks. The final thickness of the adhesive after drying was set to 4–5 μm. A nodule-treated copper foil and an adhesive-coated PI film were laminated by a hot vacuum press. The pressing conditions were a pressure of 4 MPa, temperature of 573 K and time of 1.8 ks.

After lamination, to evaluate the adhesion strength between copper foil and polyimide film, the 90° peel test was carried out under the IPC-TM 650 standard. The fractured polyimide surface was observed for investigation of the relationship between peel strength and plating product.

3. Results and discussion

Fig. 1 represents the surface morphologies of copper foil with variation in current density and plating time. At the current density of 1.0 A/dm^2 and plating time of 30 s, the first products of the size of about 100 nm were densely formed on the copper surface. When the plating time increased to 60 s, the size became bigger than the size of 1 micrometer, as shown in Fig. 1a and b. With increasing current density, the shape of the plating products became different. The white particles homogeneously covered a whole surface of copper foil (Fig. 1c). These new products were classified as the second product because of their different shapes from the first products. An increase in the nodule treatment time beyond 30 s did not result in a further increase in the size of the second product. Instead, produce agglomeration was sparsely observed in Fig. 1d.

The EDS spot analysis was conducted for the two products after nodule treatment and the results with variations in plating condition are represented in Table 1. The first product marked as point A was analyzed as copper oxide,

Table 1
Results of spot analysis by EDS

Element	Point A		Point B	
	wt%	at.%	wt%	at.%
O K	09.51	29.44	–	–
Cu K	90.49	70.56	93.40	92.89
Ni K	–	–	06.60	07.11
Total	100	100	100	100

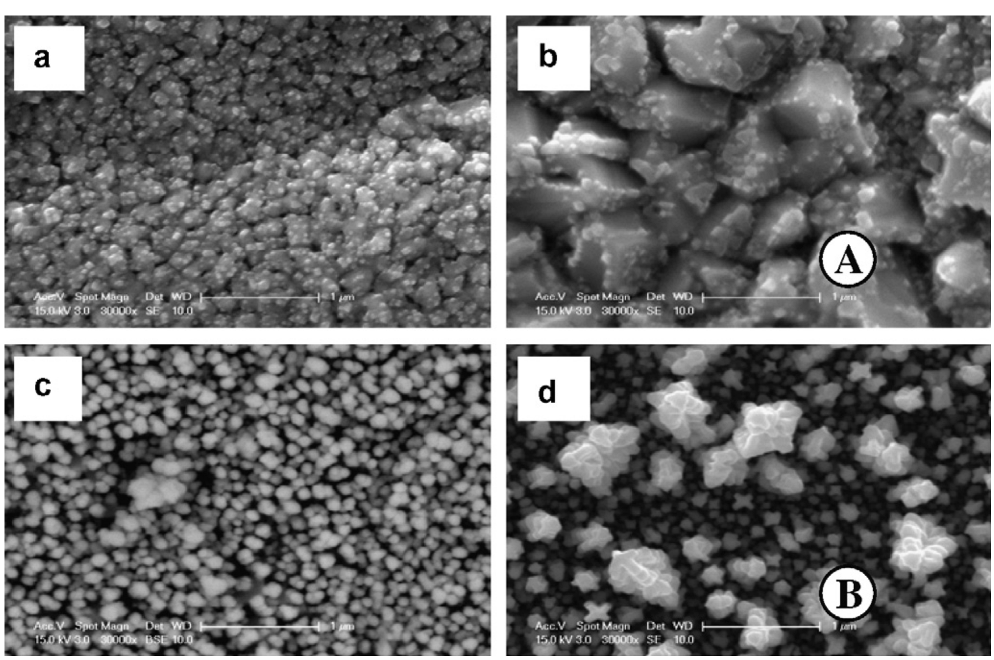

Fig. 1. Surface morphology and chemical composition variations with current density and plating time (A/dm^2-s); (a) 1–30, (b) 1–60, (c) 1.5–30 and (d) 1.5–60.

Download English Version:

https://daneshyari.com/en/article/540801

Download Persian Version:

https://daneshyari.com/article/540801

Daneshyari.com