Regular Paper

Copper Plating on Insulating Resin for Build-Up Substrate and Via Holes Using Surface Modification with Mild Acidic Permanganate

Michinori TAKAGI[1,*], Makoto SHIZAWA[1], Shintaro OHKAWA[2], Yoshio HORIUCHI[2,3] and Ichiro KOIWA[2]

[1]*Graduate School of Engineering Kanto Gakuin University 1-50-1 Mutsuura-Higashi, Kanazawa-Ku, Yokohama, Kanagawa 236-8501, Japan*

[2]*College of Science and Engineering Kanto Gakuin University 1-50-1 Mutsuura-Higashi, Kanazawa-Ku, Yokohama, Kanagawa 236-8501, Japan*

[3]*Materials and Surface Engineering Research Institute, Kanto Gakuin University: 1-50-1 Mutsuura-Higashi, Kanazawa-Ku, Yokohama, Kanagawa 236-8501, Japan*

Received Sep. 24, 2024; accepted Oct. 17, 2024

Abstract

Build-up circuit boards were applied for mounting the high-grade semiconductor chips connections. In usual to obtain enough adhesion of electroless copper plating, the insulating resin were strongly etched with high-alkaline permanganate. However large roughness degrades high-frequency electrical transmission characteristics. In this study, effective new processes to promote adhesion strength with low roughness were developed with utilizing the oxidizing agent with mild acidic permanganate, combining swelling, oxidation, alkaline treatment, and silane coupling as a pretreatment to obtain copper plating with low roughness. The surface roughness obtained was lower than that of conventional desmear processes. The adhesion strength between the plated film and insulating resin was equivalent to the surface roughened by conventional desmear. In addition, via holes formed in the build-up board after electrolytic copper plating quality were evaluated through a thermal cycle test and it was confirmed that the property has passed, and the via holes indicate high quality.

Keywords: Build-up circuit board, Insulating resin, Mild acidic permanganate, Thermal cycle test, Via hole

1. Introduction

Information communication processing system is composed of many kinds of electronic circuit modules. At present, advanced semiconductor devices are now under development. These advanced devises and other electronic components are mounted and connected on the packaging circuit board, which are made with the high-density multilayer build-up circuit board. Build-up circuit boards are widely applied to increase mounting component density. Copper plating technology was used for circuit formation on build-up circuit board [1]. Currently, the mainstream insulating resin involves roughening the resin surface through oxidation treatment under highly alkaline conditions to serve as an anchor for plating [2]. However, with the advanced information devices, GHz-band high frequencies are now used, raising concerns that large surface roughness of the insulating resin surface may adversely affect high-frequency transmission characteristics and degrade the performance of electronic devices. Additionally, the surface roughness of the resin can cause issues such as light scattering during UV exposure when forming plating resist after electroless copper plating, leading to bridging in fine pattern resist formation and copper residue during pattern formation etching [3]. To solve these issues, there have been reports of reducing roughness by improving desmear conditions or modifying the insulating resin [4,5]. There are also reports of performing copper plating after surface modification through UV irradiation in a solution dispersed with titanium oxide [6,7].

*Corresponding author: m-takagi0813@nifty.com