

*Note***Surface Nano-Roughness Enhanced Adhesion Strength of Electroless Nickel-Phosphorus on Silicon Nitride-Aluminum-Polyimide Mixed Substrates****Tomiyuki ARAKAWA¹, Nobuaki WATANABE², Tatsunosuke NAKADA² and Ichiro KOIWA^{2,*}**¹ *Institute of Science and Technology, Kanto Gakuin University, 1-50-1 Mutuurahigasi, Kanazawa-ku, Yokohama 236-8501, Japan*² *College of Science and Engineering, Kanto Gakuin University, 1-50-1 Mutuurahigasi, Kanazawa-ku, Yokohama 236-8501, Japan*

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Abstract

Strong adhesion strength of electroless Ni-P on mixed-substrates of silicon nitride, aluminum and polyimide is required for a wafer-level chip size package. In this paper, the relation between the adhesion strength of electroless Ni-P on silicon nitride, aluminum and polyimide substrates and the nano-roughness of substrate surface was discussed. The fractal dimension which reflected the behavior of nano-roughness of substrate surface was adapted. Consequently, silicon nitride provided the largest fractal dimension and adhesion strength among substrate surfaces after pretreatment.

Keywords: Electroless nickel-phosphorus, Silicon nitride-aluminum-polyimide mixed substrate, Fractal dimension, Adhesion strength

1. Introduction

Smaller as well as higher performance devices are desirable for mobile and wearable electrical apparatus. High density packaging technology has been developed in order to be realized those. A wafer-level chip size package (W-CSP) is a promising candidate for reducing device size. A metallization is carried out onto mixed surface which were composed of passivation of silicon nitride and polyimide, pads of aluminum in W-CSP fab process. In general, the metallization is performed by electroless deposition on mixed substrates because silicon nitride and polyimide are dielectrics. The adhesion strength of metallization is required to be enough to metalize on silicon nitride, aluminum and polyimide mixed substrates. We have studied the influence of complexing agents on adhesion strength of electroless Ni-P deposits to silicon nitride-aluminum-polyimide mixed substrates [5]. The pretreatment method of substrate surfaces has provided tight adhesion of electroless Ni-P deposits to silicon carbide/aluminum composites [1]. The surface modification of argon plasma-pretreated polyimide has promoted enhancement of adhesion strength of electroless copper deposits [2]. The

adhesion strength of electroless copper deposits was increased by argon plasma-pretreated polyimide which was subjected to UV-induced surface graft copolymerization [3]. Li et.al. has been reported that alkaline etching and nickel salt activation enhanced the adhesion strength of electroless nickel deposits to polyimide for metallization [4]. On the other hand, it has been known that the adhesion strength is improved by the anchor effect. The anchor effect is possible to be affected by the surface roughness of substrate. The behavior of surface roughness is reflected by the fractal dimension [6].

In this paper, the adhesion strength of electroless Ni-P to silicon nitride-aluminum-polyimide mixed substrates is discussed from the point of view of the surface nano-roughness of substrates based on the relation between adhesion strength and fractal dimension.

2. Experimental method

Three kinds of samples, silicon nitride, aluminum and polyimide films were prepared in order to compare the adhesion strength of electroless Ni-P on them. Silicon oxides with the

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