Structure and Properties of Ni Electrodeposited Copper Mold Upon Annealing

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ABSTRACT

Various types of failure were observed on the metallography specimens prepared from used Ni-electroplated Copper mold with star-like cracks presented at the region around meniscus and with the exposure of Cu and the decohesion of Ni layer at the exit end which was suffered to excessive wear.The rmal fatigue resulted in the development of star-like cracks.The coarsening of Ni layer caused the decrease of Ni deposit hardness which in turn resulted in the excessive wear. This study aims at establishing the "processing-structure-properties" of electroplated Ni deposit. The structure and properties of various Ni deposits after annealing were also investigated so that the electroplating parameters to prepare the Ni deposit with betterhigh-temperature performance can be made. Furthermore the adhesion of Ni deposit to Cu was measured with emphasis on the effect of annealing treatments. Current density, PH value and temperature of electrolyte were the major plating parameters studied. Properties of Ni deposit were measured via micro-hardness, internal stress and interfacial shear strength. Microstructural characterization of Ni deposit was performed using optical microscopy, X-ray pole figure measurement and cross-sectional transmission electron microscopy.It is found that the relatively-harder Ni deposit plated at0.5 A/dm2 is associated with the highly-dislocated defects and twins. Hardness of Ni deposite decreases gradually with annealing temperatures of less than 300 oC. A dramatic decrease in Ni deposit hardness occurred while the annealing temperatures go from 300 to 400 oC, indicating recrystallization of Ni deposit takes place with this temperature range. At the same time, the columnar grains of Ni deposit evolved into equi-axed grains with an increasing average grain size with annealing temperature. Ni deposits made from 50 or 60 oC electrolytes exhibit higher hardness than those plated at 30 or 40 oC electrolytes. Unlike the Ni deposits made from 50 or 60oC which consisted of fine equi-axed grains after annealing above 500 oC,the Ni deposits plated at 30 or 40 oC electrolytes still retained their columnar grain structure even after 600 oC annealing. Although the Ni deposits plated at various PH values have different hardness, the hardness of each Ni deposit decreases abruptly once the annealing temperature is higher than 300 oC. Ni deposits plated from electrolytes of PH values of 3 or 3.5 consist of a mixed columnar and equi-axed grain structure after 400 oC annealing. After 600 oC annealing the Ni deposits exhibit an equi-axed grain structure. During the measurement of interface shear strength fract ure occurred within Cu substrate for both as-deposited and annealed Ni-plated Cu. A systematic procedure has been established to assess the in-laboratory performance of Ni-electrodeposited Cu mold. The techniques established and the findings of this study provide a basis for Ni electrogalvanizers to modify the electroplating parameters for plating Ni deposits with better performance or to develop the new products of better performance.

Keywords : 銅模 ; 鍍鎳

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