Influence of EDTA/THPED Dual-Ligand on Copper Electroless Deposition

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Single ligand electroless plating process has been studied extensively in the past decades, this study investigates the advantages of using a dual ligand system (EDTA/THPED) on electroless plating process. Electrochemistry techniques including mixed potential and linear sweep voltammetry (LSV) are used to examine the fundamental deposition mechanism of dual ligand system, providing critical information for dual ligand formulation design. Mixed potential tests indicated that increasing the Tetrakis (2-hydroxypropyl) ethylenediamine (THPED) concentration negatively shifts the electrode potential. The overall process was divided into three regions: induction, transition and stability. The degree of potential negatively shifted at each region was related to absorption, the type of redox reaction, ion diffusion and migration. Electrochemical analyses showed that there was an obvious peak for all anodic and cathodic reactions, respectively at around -0.42V and -0.57 V, whereby the current density depended on the THPED concentration. Moreover LSV study demonstrated control factor of autocatalytic reactions is cathodic reduction process of copper ion. The electroless deposition rate results were also in good agreement with mixed potential and electrochemical measurements, and the copper deposition rate increased significantly with the addition of THPED, and showed parabolic growth pattern. Metallographic studies of the dual-ligand electroless copper deposits revealed that their topographic structures had uniform and fine particle distribution, and a high-purity product without Cu₂O inclusions was detected. Copper layers displayed that the addition of THPED favored the formation of the preferred orientation on the (220) lattice plane.

Keywords: Electroless copper; Ligand; Mixed potential

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