

基板的電漿處理對銅化學氣相沉積特性之影響

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摘要

本論文以自行組建之多腔體低壓化學氣相沉積 (Cu CVD) 系統，使用 Cu(hfac)TMVS + 2.4wt% TMVS 當作先驅物(precursor)，在 TaN 及 TaSiN 基板上作銅化學氣相沉積，探討 Cu CVD 的活化能、銅膜的電阻率、表面型態、以及結晶性等性質，並且分別以物理性的氬氣電漿(Ar-plasma)以及化學性的氬氣電漿(H₂-plasma)和氮氣電漿(N₂-plasma)對基板做前處理，探討其對銅成核及銅膜特性的影響。吾人發現銅化學氣相沉積在氬氣電漿以及氬氣電漿處理過的基板上，皆具有較快的成核速率和較小的銅核顆粒濕潤角(wetting angle)；相反的，經過氮氣電漿處理過的基板則具有較慢的成核速率以及較大的銅核濕潤角。實驗結果也顯示沉積在氬氣電漿以及氬氣電漿處理過的基板上之銅膜皆具有接觸較佳的晶粒、較平坦的表面、以及較大的 Cu(111)/Cu(200)晶向比。銅膜沉積後，若再於氮氣中作 400°C 的 30 分鐘熱處理，則可進一步提升銅膜的(111)結晶取向、增進表面平滑度，以及降低銅膜的電阻率。

Effects of Plasma Substrate Treatment on Cu-CVD

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Abstract

This thesis studies the copper chemical vapor deposition (Cu CVD) on TaN and TaSiN substrates as well as the effects of substrate plasma treatment (by Ar-, H₂-, or N₂-plasma) on the Cu nucleation and the Cu films property. The Cu CVD was performed using a liquid metalorganic compound of Cu(hfac)TMVS with 2.4% TMVS additive as the Cu precursor at a pressure of 150mtorr over a temperature range of 140 to 240°C. The activation energy, film resistivity, surface morphology, and texture of Cu films were investigated. Effects of Ar-, H₂- and N₂-plasma treatment on substrates were explored with respect to Cu nucleation. It was found that Cu CVD on Ar- and H₂-plasma-treated TaN and TaSiN substrates all exhibited higher nucleation rate, and smaller wetting angle of the nucleated Cu grains, whereas the N₂-plasma treatment resulted in lowered nucleation rate and increased wetting angle. Moreover, the Cu films deposited on Ar- and H₂-plasma-treated TaN and TaSiN substrates all exhibited better contacted grains, smoother film surface, and higher intensity peak ratio of Cu(111)/Cu(200) reflections. Post-deposition thermal annealing at 400 °C resulted in reduced film resistivity, improved surface smoothness, and increased intensity peak ratio of Cu(111)/Cu(200) reflections.