Stabilization of α-Ta by WTi ultra-thin underlayer

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Abstract

This study reports on the influence of WTi underlayer on the structural and electrical properties of refractory tantalum (Ta) thin films. WTi/Ta bilayers have been deposited using a planar DC magnetron sputtering apparatus from WTi alloyed (70:30 at%) and Ta targets in pure Ar working gas, at constant power discharge, without substrate bias and external heating. WTi deposition was carried out under a working pressure of 0.53 Pa while Ta deposition was under pressure ranged from 0.14 to 1.4 Pa. Preliminary studies show that WTi films have a α-W structure with a {110} fiber texture. For thin (WTi 10 / Ta 100 nm) films a stress transition from compressive-to-tensile stress state has been observed as the working pressure increases using both Stoney and X-Ray Diffraction ex-situ methods. On the contrary, for ultra-thin (WTi 10 / Ta 10 nm) films, residual stress remains almost constant whatever the working pressure applied (Stoney method). A critical thickness of WTi underlayer is shown at 4 nm which corresponds to the film continuity thickness threshold determined by in situ optical spectroscopy. Thin films microstructure and epitaxial relationships are determined by FIB-TEM observations. α-Ta films with WTi underlayer offer better electrical conductivity and diffusion barrier performance than conventional WTi films.

Keywords: Microstructure, stress, electrical resistivity, Ta films

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