Title : Diffusion barrier properties of ALD TiSiN Films

Authors : Jerry Mack, Jaeseok Heo, Srishti Chugh, Hae Young Kim, Somilkumar J. Rathi, Niloy Mukherjee

Affiliations : Eugenus, Inc., 677 River Oaks Parkway, San Jose, CA, USA, 95134

Abstract :

The decreasing feature sizes and increasing aspect ratios in semiconductor process flows have imposed stringent requirements on the physical and electrical properties of metal-to-semiconductor interfaces. This has resulted in fundamental material challenges for low-resistance contacts and ultra-thin diffusion-barrier films. Physical vapor deposition (PVD) based TiN film is a widely used diffusion barrier layer. However, deposition of ultra-thin TiN exhibits pronounced islanding which leads to rough film with polycrystalline grain structure. Furthermore, inhomogeneities due to grain boundaries offer diffusion pathways and lead to device degradation. In the current study, we present our findings on the diffusion barrier properties of amorphous ternary alloy films composed of Ti, Si and N (TiSiN), an excellent alternative to TiN films. These films were grown using Atomic Layer Deposition (ALD) technique on the Eugenus 300mm QXP commercial mini-batch reactor. In one set of experiments, TiSiN films were deposited on highly-doped polycrystalline Si:B films followed by diffusion studies of boron. In another set of experiments, fluorine precursor based CVD WSi_x film was deposited on TiSiN, followed by diffusion studies of fluorine. Secondary Ion Mass Spectrometry (SIMS) and High-resolution electron energy loss spectroscopy (HREELS) were utilized to detect the effectiveness of the barrier film to prevent boron and fluorine diffusion.