RESIDUAL STRESSES AFTER CMP ON THIN FILMS

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In needs of global surface planarization in the semiconductor manufacturing industry as the feature sizes of Integrated Circuit (IC) components continue to shrink, Chemical Mechanical Polishing (CMP) has emerged as the fasted-growing operation in the past decade. The CMP processes employ both chemical and mechanical interactions to planarize chemically modified surface layers using slurries composed of chemicals and submicron-sized particles. Consequently, the success of the high quality production for IC components depends considerably on the performance of the CMP processes. Thus, it is necessary to evaluate the CMP produced surface integrity such as surface finish and surface stresses to enhance the performance of CMP.

The goal of this study was to determine the surface and subsurface residual stress after CMP processes for thin films. Two different thin films of W and TiN on silicon wafer were chemical-mechanical polished at designed parameters with different down pressures and relative velocities to generate the stress differences on surface and below surface. The stress measurements, then, were performed on the PANalytical X'Pert MRD diffractometer. In order to study the stresses of thin films below 1 μm, the diffractometer was aligned to the configuration of grazing-incidence X-ray diffraction (GIXRD) with its principles based upon the conventional $\sin^2\Psi$ method to measure the changes of lattice strains. According to Hooke's law, the lattice strains were converted to residual stresses, assuming the thin films are elastically isotropic. For the subsurface residual stresses, a multi-reflection method was used to measure the stress gradients below the surface as a function of GIXRD penetration depth and film thickness. The variations of surface and subsurface residual stresses from different CMP planarization conditions were evaluated with the distribution of the stress gradient along the depth of thin films.

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