Optimization of Silicon Nitride Process For Post Copper CMP Nitride barrier Film

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In copper (Cu) dual-damascene process, silicon nitride had been widely used as diffusion barriers against Cu oxidation and diffusion. This silicon nitride deposition process mainly consists of three steps; pre-heat, chemical treatment and silicon nitride film deposition. The pre-heat is to stabilize Cu resistance, and chemical treatment is used to remove Cu_2O for improving the adhesion between Cu surface and silicon nitride film. Insufficient treatment time would lead to delamination at the Cu and silicon nitride interface. The total time (thermal budget) of the pre-heat and treatment would influence the copper dual-damascence integration performance. Longer thermal budget would cause Cu hillock issue, which influence the Stress-Migration performance or induce other integration problems. Similarly, the bulk silicon nitride film property is also important for Cu dual-damascene process. Silicon nitride film would influence Cu diffusion barriers ability, via profile, via resistance and electron-migration performance. Based on experiment results, 10sec pre-heat time and 15sec NH3 treatment time was optimize for reliability test, including Cu_2O remove rate, hillock performance, adhesion test and stress migration test. Silicon nitride film with higher density and higher tensor film was good choice as Cu barrier layer.

Keywords: Plasma Enhanced Chemical Vapor Deposition (PECVD) ; Silicon Nitride ; barrier layer;