Single-Wafer Hot Wall Rapid Thermal CVD of Silicon Nitride Films

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Abstract

Silicon nitride films were deposited from dichlorosilane (DCS) and silane as silicon source gases reacted with ammonia by low pressure CVD using newly developed hot-wall single-wafer rapid thermal process (RTP) modules. Single-wafer RTP offers shorter cycle time and better temperature control than conventional batch furnace processing and is becoming necessary as future wafer production moves to 300mm diameter for cost reduction.

The deposition of 20-40Å silicon nitride films from DCS and NH_3 showed excellent thickness uniformity and repeatability. Conformal coverage of nitride over deep trenched substrates was also demonstrated by cross section TEM analysis. The hot-wall reactor configuration suppresses the condensation of NH_4Cl solid byproduct. Electrical properties of the as-deposited DCS-based nitride films were comparable to those of films processed in a vertical batch furnace. Post-deposition anneal effect on the electrical properties of the nitride films was also studied.

Both thick (700Å) and thin (20Å) nitride films were deposited from silane at a temperature range from 700ºC to 740ºC. A high NH_3 to SiH_4 gas flow ratio of over 100:1 was required for stoichiometry control of Si_3N_4. High deposition rates of silicon nitride films up to 1000Å/min can be achieved. SEM cross-section analysis of the films deposited on spacer patterns revealed that film thickness between dense lines and isolated lines were similar.

In this paper, the RTCVD processes and characterization of the nitride films will be discussed.