Effect of *in situ* laser radiation on the parameters of the alumina films fabricated by atomic layer deposition

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The influence of wafer irradiation with a wavelength of 970 nm light of diode laser on the process of atomic layer deposition (ALD) of aluminum oxide films by precursors trimethylaluminium (TMA) and water vapor is studied. It is supposed that interaction of intensive optical radiation with adsorbed precursors on surface could initiate its local desorption. Selective removal of adsorbed precursors from different materials could be promising for development of area selective atomic layer deposition.
The sample was exposed to laser radiation at the stages of pumping of the reactor after supplying each precursor. As a result of complex researches on the basis of spectral ellipsometry, probe profilometry, x-ray diffractometry and secondary ion mass spectrometry was conducted.
The samples of 20-25 nm thick Al_2O_3 films were deposited in FlexAl ALD tool (Oxford instruments plasma technology, UK). This process is known as truly self limited and hence process dependence on external parameters (wafer temperature, dosage of precursors, pressure) is flat in wide interval [2]. That provides wide "process window", in which stable and reproducible film properties can be achieved. Table was heated to 300°C. TMA was dosed for 20 ms from the babbler heated to 35°C, and water vapor was dosed for 200 ms, from the vessel cooled to 18°C. The central part of the silicon wafers with a diameter of 3 cm in the process of 200 cycles of ALD in the purge stages was irradiated for 5 seconds by a laser with a wavelength of 970 nm and a power density of 0.29 W/cm^2.
The thickness of alumina (Al_2O_3) films and the uniformity of their distribution over the surface of the wafers were measured by a J.A. Woollam M-2000X spectral ellipsometer with automated moving table in spectral range of 246-988 nm with mapping facilities.
The average density of aluminum oxide films was measured by X-ray reflectometry on the SmartLab tool. The geometry of a parallel beam of X-ray radiation with a wavelength λ ($CuK_{\alpha 1}$) = 0.15406 nm in the scanning mode 2θ with an angular pitch $\theta = 0.004°$ was used. The alumina film obtained without *in situ* laser irradiation of the wafer has an average density in the range (3.24-3.23) g/cm^3, while the aluminum oxide film formed in the process with laser radiation had an average density of 2.94-3.05 g/cm^3.
The studies carried out on the SmartSPM scanning probe microscope revealed practically no significant difference in altitude (film thickness) between irradiated and non-irradiated parts of wafer, as well as changes in surface relief (roughness).
SIMS analysis of Al/O ratio depending on the depth was performed, showing negligible differences between treated and untreated parts of wafers.
In addition, local laser irradiation with different power densities during 5 seconds in the purge stages in the process of 200 cycles of ALD of Al_2O_3 films changes (by (0.6-0.74) nm) the total thickness of the films deposited on the wafer, probably due to the heating of the wafers with respect to temperature of table (300°C).

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