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Change in the band alignment of silicon oxynitride films as a function of plasma nitridation condition

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Effects of plasma nitridation on the incorporated nitrogen concentration into SiO_2 film, chemical bonding structures and band alignment of silicon oxynitride film by plasma nitridation have been studied. Interfacial chemical SiO_2 layer growing on silicon (100) substrate during wet cleaning and rinsing operation, chemical oxide highly hydrated with composition departing from stoichiometric SiO_2 (SiO_x with $x<2$). Chemical bonding states of thin oxynitride film have been investigated by high-resolution x-ray photoelectron spectroscopy (HRXPS). Band alignment has been investigated by reflection electron energy loss spectroscopy (REELS) and XPS valence spectra. The nitrogen concentration incorporated into the film is dependant on the N_2 plasma conditions such as the plasma generation power, time, and substrate temperature. Valence band offsets are slightly changed depending on the composition of silicon oxynitride films. It is suggested that the changes in chemical states closely depend on the distribution of nitrogen contents diffused into silicon oxynitride films. The band gap of film treated with nitrogen plasma decreases comparing that of SiO_2 film, which is resulted from the change in valance band of O 2p.