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Oxidation Mechanism of Si in the Growth of SiO_x Thin Film by Ion Beam Sputter Deposition.

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Silicon rich silicon oxide (SiO_x) thin film has attracted many research interests because the Si nanocrystals in SiO_2 matrix can act as a source of light emission at the range of visible light due to quantum confinement effect. The size and density of Si nanocrystals are key parameters to determine the energy and intensity of the photoluminescence. Therefore, elucidation of the detailed mechanism of Si oxidation is required to control the formation of Si nanocrystals in SiO_2.

SiO_x films were grown on p-type Si(100) by ion beam sputter deposition under oxygen gas ambient. The thin films grown at the deposition chamber could be transferred to a surface analysis chamber without exposing to the air. Therefore, the oxygen content(x) of the SiO_x was directly analysed by *in-situ* x-ray photoelectron spectroscopy (XPS). The relative sensitivity factor (RSF)s of Si 2p and O 1s peaks were calculated by *in-situ* XPS analysis of the stoichiometric SiO_2 thin films where x is 2.

Oxidation of Si during the growth of silicon oxide (SiO_x) films by ion beam sputter deposition deposition was systematically investigated by *in-situ* XPS. The variation of oxygen content(x) showed that the oxidation of Si can be composed of adsorption-induced chemical oxidation and diffusion-induced thermal oxidation. The discrepancy of the oxidation patterns at high temperatures above 400oC was well correlated with the effect of thermal oxidation. Although, the chemical oxidation is dominant at low temperature, thermal oxidation acts as a main role in the Si oxidation at high temperatures. The decrease of metastable intermediate states with the increase of substrate temperature was consistent with the serious decrease of growth rate of SiO_2 and the phase separation of Si and SiO_2.