Annealing and deposition effects of the chemical composition of silicon rich nitride

Silicon-rich nitride, deposited by LPCVD, is a low stress amorphous material with a high refractive index. After deposition the silicon-rich nitride thin film is annealed at temperatures above 1100 oC to break N-H bonds, which have absorption peaks in the wavelength band important for optical telecommunication. However, silicon clustering appears in the thin films when annealing above 1150 oC. Clustering is undesirable in waveguide materials because the localized variations of the refractive index associated with the clusters lead to Raleigh scattering, which can cause significant propagation loss in optical waveguides. This means that the annealing temperature must be high enough to break the N-H bonds, but no so high as to produce clusters. Therefore, the process window for an annealing step lies between 1100 and 1150 oC. The chemical composition of amorphous silicon-rich nitride has been investigated by Rutherford back scattering (RBS) and X-ray photoelectron spectroscopy (XPS). The influence of deposition parameters and annealing temperatures on the stoichiometry and the chemical bonds will be discussed. The origin of the clusters has been found to be silicon due to severe silicon out-diffusion from the substrate during annealing at temperatures above 1100 oC.

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