

PECVD 실리콘질화막에 대한 이온빔 방사효과
(ION IRRADIATION EFFECT ON PECVD
SILICON NITRIDE FILMS)

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Hydrogenated silicon nitride films were deposited on silicon wafers in PECVD reactor. Substrate temperatures for the film deposition were 200, 300, and 400 °C. Two different gas mixtures, $[\text{SiH}_4] + [\text{NH}_3]$ and $[\text{SiH}_4] + [\text{NH}_3] + [\text{N}_2]$, were used. 2.5 MeV $^4\text{He}^{++}$ ions with a beam current of 10 nA were irradiated into the target at room temperature. Elastic recoil detection (ERD) analysis and Rutherford backscattering (RBS) measurements were carried out simultaneously with the He ion irradiation for the measurement of hydrogen content change during the irradiation. Fourier transform infrared (FTIR) was also used to observe hydrogen bonds density in the film before and after the irradiation.

He ion irradiation into PECVD silicon nitride films altered a hydrogen contents of the films. A large decrease of hydrogen content was found in samples having initially more than 27 atomic % hydrogen. The hydrogen content was decreased exponentially at the initial stage of irradiation and saturated after about $150 \mu\text{C}/\text{cm}^2$ irradiation. The residual hydrogen compositions at the saturation level were about 27 atomic % nearly regardless of the film deposition conditions, silicon and nitrogen atomic ratios and initial hydrogen contents. And this residual hydrogen level was the same with the initial hydrogen content of the films which did not show a hydrogen loss during the irradiation. Therefore PECVD silicon nitride films seem to have a characteristic level of hydrogen content with which they are stable against MeV He ion beam irradiation. In some samples hydrogen bubbles has been found and these resulted in a abnormal hydrogen loss behavior.

Hydrogen bonds breaking were found in all the samples after the irradiation. Between two hydrogen bonds, Si-H and N-H, the decrease of N-H bond density was more severe than that of the Si-H bonds. The amount of liberated hydrogen bonds was proportional to the amount of hydrogen loss measured by ERD. However, small fraction of hydrogen bonds breaking was also observed in the samples which did not show a hydrogen loss by ERD measurement.