CHF3/C2F6 반응성이온 건식식각으로 오염된 실리콘 표면의 특성과 여러가지 후처리효과 연구

(Characteristics of contaminated silicon surface due to CHF3/C2F6 reactive ion etching and Post etch treatments for removal of surface residue)

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Reactive ion etching (RIE) of SiO_2 on Si in fluorocarbon plasmas is a standard process in the production of very large scale integrated (VLSI) devices. But it can cause damage and contamination in the plasma exposed materials. In fact, plasma species can be trapped in the silicon matrix, and residue layer can be made up of reactant species and reaction products. In our previous results [1], the residue film due to the exposure of silicon surface to CHF_3 / C_2F_6 reactive ion plasma has been revealed to consist of mainly carbon and fluorine. The residue film has 9 kinds of different bonds. And through angle resolved X-ray photoelectron spectroscopy (XPS) analysis, O-F bond over C-F polymer which contains C-CFx (x=1-3), C-F1, C-F2, and C-F3 bonds are found at the surface. Between C-F polymer layer and the silicon substrate, C-C/H, Si-C, Si-O, and Si-F bonds exist. And through the depth profile analysis using secondary ion mass spectrometry (SIMS), it has been shown that a ~500 angstrom thick silicon layer is contaminated with mainly carbon and fluorine. In this study, for detailed interpretation of modified silicon surface after RIE in a CHF_3/C_2F_6 plasma, ion channeling experiment and cross-sectional transmission electron microscopy (TEM) works have been done. A flat and uniform residue layer of about 40 angstrom in thickness has been observed. The interface is sharply defined and smooth. Neither point defect cluster nor distinct planar defect has been found in substrate silicon lattice image. This is also confirmed by comparison scaled and energy shifted silicon surface peak of a control sample with the reactive ion etched sample using ion channeling Rutherford backscattering spectrometry (RBS).

And as post etch treatments to remove silicon surface residue resulting from the RIE, the effects of NF_3, Cl_2, and SF_6 plasma treatments have been characterized using XPS. Among them, NF_3 treatment has been revealed to be the most effective. With 10 seconds exposure to NF_3 plasma, fluorocarbon residue film decomposes and the remained fluorine mostly binds to silicon. And the fluorine completely disappears after the following wet cleaning.

1. H.-H. Park, K.-H. Kwon, B.-H. Koak, S.-M. Lee, O.-J. Kwon, B.-W. Kim, J.-W. Lee, J.-B. Yoo, and Y.-K. Sung in Chemical Surface Preparation, Passivation and Cleaning for Semiconductor Growth and Processing, edited by R.J.Nemanich, C.R.Helms, M.Hirose, and G.W.Rubloff (Mat. Res. Soc. Proc. **259**, San Francisco, CA, 1992) pp. 219-224.