반응성 이온 건식식각시 형성되는 손상층의 제거를 위한 O_2 플라즈마 및 열처리 효과

(O_2 plasma and thermal treatment effects for removal of damaged layer formed by reactive ion etching)

한국전자통신연구소 : 박 형호, 권 광호, 곽 병화, 이 수민, 권 오준
김 보우

Reactive ion etching(RIE) of SiO_2 on Si in fluorocarbon plasma is a standard process in the production of very large scale integrated(VLSI) devices. But it can cause damage and contamination effects in 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. Various fluorocarbon plasma and their interaction with Si or SiO_2 surface have been analyzed in recent years[1,2]. And for removal of silicon substrate residues resulted from RIE, heat treatment in dry oxygen or rapid thermal anneal(RTA) treatment have been studied[3,4]. Although oxidizing process by exposing to an O_2 plasma is used actually for removing the surface residues[5], this approach is announced to have several problems as consumption of silicon during the cleaning and leaving the silicon lattice damage and trapped impurities.

The effects of SiO_2 reactive ion etching in CHF_3/C_2F_6 on the surface properties of the underlying Si substrate were studied by X-ray Photoelectron Spectroscopy(XPS) and Secondary Ion Mass Spectrometry(SIMS) techniques. Angle-resolved XPS analysis were carried out as non-destructive depth profile one for investigating the chemical bonding states of silicon, carbon, oxygen and fluorine. The residue layer consists of C-F polymer. O-F bond was found on the top of the polymer layer and Si-O, Si-C and Si-F bonds

were detected between Si substrate and polymer film. A 60nm thick damaged layer of silicon surface mainly contains carbon and fluorine.

Decomposition of polymer residue film begins at 200°C and above 400°C carbon compound as graphite mainly formed by using in-situ heating facility in ultra high vacuum(UHV) XPS chamber. It revealed that thermal decomposition of residue could be compeleted by RTA treatment above 800°C under nitrogen atmosphere and out diffusion of carbon and fluorine in damaged layer was observed. When O_2 plasma treatment was proceded, the recovery of damaged layer could be also obtained by rapid anneal at 500°C.

REFERENCES

[1] G.S. Oehrlein, R.M. Tromp, J.C. Tsang et al.
J. Electrochem. Soc., 132(6), 1441(1985)

[2] X.C. Mu, S.J. Fonash, G.S. Oehrlein et al.
J. Appl. Phys., 59(8), 2958(1986)

[3] G.S. Oehrlein, J.G. Clabes and P. Spirito
J. Electrochem. Soc., 133(5), 1002(1986)

[4] S.J. Fonash, R. Singh, A. Rohatgi et al.
J. Appl. Phys., 58(2), 862(1985)

[5] G.S. Oehrlein, J.G. Scilla and S.J. Jeng
Appl. Phys. Lett., 52(11), 907(1988)