

Effects of Cl₂ or SF₆ plasma treatments on removal of residue on reactive ion etched Si surface

Hyung-Ho Park, Kwang-Ho Kwon, Byong-Hwa Koak and Oh-Joon Kwon

Semiconductor Technology Division, ETRI, P.O.Box 8, Daeduk Science Town, Daejeon, 305-606, Korea

Reactive ion etching of SiO₂ on Si in a 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 [1]. In fact, plasma species can be trapped in the silicon matrix, and residue layers can be made up of reactant species and reaction products. Various fluorocarbon plasma treatments and their interaction with the Si or SiO₂ surfaces have been analyzed in recent years [2]. For removal of silicon surface residue resulting from the RIE, heat treatment in dry oxygen or rapid thermal anneal treatment have been studied [3]. Although oxidizing process by exposing to an O₂ plasma is used for removing the surface residues, this approach presents a problem of the silicon lattice damage and trapped impurities.

In this study, the surface residue due to CHF₃ / C₂F₆ RIE process has been characterized. The observed three major modifications are (i) a ~50nm thick silicon layer which contains carbon and fluorine, (ii) 2~3nm thick residue layer composed entirely of carbon, fluorine, oxygen and hydrogen on the silicon surface and (iii) damaged silicon layer near surface. For recovery of the modified silicon surface, reactive ion etched specimens have been exposed to an oxygen plasma. By XPS analysis, the effect of an O₂ plasma treatment has been revealed to be completed within 20min. And the effects of Cl₂ and SF₆ plasma treatments have been also studied. After several ten seconds exposure, decomposition of residue layer has been found. And followed wet cleaning process has been revealed to be effective for removing of contaminated impurities.

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