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Role of gas flow rate during etching of hard-mask layer to extreme ultra-violet resist in dual-frequency capacitively coupled plasmas

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In the nano-scale Si processing, patterning processes based on multilevel resist structures becoming more critical due to continuously decreasing resist thickness and feature size. In particular, highly selective etching of the first dielectric layer with resist patterns are great importance. In this work, process window for the infinitely high etch selectivity of silicon oxynitride (SiON) layers and silicon nitride (Si3N4) with EUV resist was investigated during etching of SiON/EUV resist and Si3N4/EUV resist in a CH2F2/N2/Ar dual-frequency superimposed capacitive coupled plasma (DFS-CCP) by varying the process parameters, such as the CH2F2 and N2 flow ratio and low-frequency source power (PLF). It was found that the CH2F2/N2 flow ratio was found to play a critical role in determining the process window for ultra high etch selectivity, due to the differences in change of the degree of polymerization on SiON, Si3N4, and EUV resist. Control of N2 flow ratio gave the possibility of obtaining the ultra high etch selectivity by keeping the steady-state hydrofluorocarbon layer thickness thin on the SiON and Si3N4 surface due to effective formation of HCN etch by-products and, in turn, in continuous SiON and Si3N4 etching, while the hydrofluorocarbon layer is deposited on the EUV resist surface.