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Role of CH2F2 and N-2 Flow Rates on the Etch Characteristics of Dielectric Hard-mask Layer to Extreme Ultra-violet Resist Pattern in CH2F2/N2/Ar Capacitively Coupled Plasmas

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The effects of CH2F2 and N2 gas flow rates on the etch selectivity of silicon nitride (Si3N4) layers to extreme ultra-violet (EUV) resist and the variation of the line edge roughness (LER) of the EUV resist and Si3N4 pattern were investigated during etching of a Si3N4/EUV resist structure in dual-frequency superimposed CH2F2/N2/Ar capacitive coupled plasmas (DFS-CCP). The flow rates of CH2F2 and N2 gases played a critical role in determining the process window for ultra-high etch selectivity of Si3N4/EUV resist due to disproportionate changes in the degree of polymerization on the Si3N4 and EUV resist surfaces. Increasing the CH2F2 flow rate resulted in a smaller steady state CHxFy thickness on the Si3N4 and, in turn, enhanced the Si3N4 etch rate due to enhanced SiF4 formation, while a CHxFy layer was deposited on the EUV resist surface protecting the resist under certain N2 flow conditions. The LER values of the etched resist tended to increase at higher CH2F2 flow rates compared to the lower CH2F2 flow rates that resulted from the increased degree of polymerization.

Keywords: extreme ultra-violet (EUV), line edge roughness (LER), dual-frequency superimposed capacitive coupled plasmas (DFS-CCP)