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Angular dependence of Si3N4 etch rates and SiO2-to-Si3N4 etch selectivity in C4F6/O2/Ar/CH2F2 plasmas

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Plasma etching of SiO_2 contact holes is one of the key processes in the fabrication of ultra large scale integrated circuits. During contact-hole etching, Si_3N_4 films are usually used as mask materials. An increase in the etch rates at the curved Si_3N_4 surface is known to lower the etch selectivity of SiO_2 to Si_3N_4, resulting in device failure. Therefore, it is important to control the angular dependence of Si_3N_4 etch rates and SiO_2-to-Si_3N_4 etch selectivity.
In this work, the angular dependence of Si_3N_4 etch rates and SiO_2-to-Si_3N_4 etch selectivity in $C_4F_6/O_2/Ar/CH_2F_2$ plasmas was investigated using a specially-designed Faraday cage system.
The etching was carried out in an inductively coupled plasma system. The discharge gas was a mixture of $C_4F_6/O_2/Ar/CH_2F_2$. The flow rate of CH_2F_2 was varied to investigate the effects of CH_2F_2 on the angular dependence of Si_3N_4 etch rates and SiO_2-to-Si_3N_4 etch selectivity. The shape of the normalized etch yield (NEY) of Si_3N_4 showed a maximum at angles between 45°and 70°. However, the maximum value of NEY and the ion-incident angle at the maximum NEY were affected by the CH_2F_2 ratio. In addition, the angular dependence of the etch selectivity of SiO_2-to-Si_3N_4 was strongly affected by the CH_2F_2 ratio.

Keywords
nitride etching
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faraday cage