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Highly selective etching of silicon nitride to CVD a-C in dual-frequency capacitively coupled CH_2F_2/H_2plasmas

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For the fabrication of a multi level resist (MLR) based on amorphous carbon (a-C) layer and Si_3N_4 hard-mask layer etch selectivity of the Si_3N_4/a-C layer becomes increasingly critical with the feature size reduction. In this work, the highly selective etching process of the Si_3N_4 layer(≅ 300 nm), using chemical-vapor-deposited (CVD) a-C etch-mask (≅ 300 nm), was investigated by varying the following process parameters in CH_2F_2/H_2/Ar plasma: etch gas flow ratio, high-frequency source power(P_{HF}) and low-frequency source power(P_{LF}) in a dual-frequency superimposed capacitively coupled plasma etcher. It was found that infinitely high etch selectivities of the Si_3N_4 layers to the CVD a-C on patterned wafers could be obtained for certain process conditions. In particular, the etch gas flow ratio was found to play a critical role in determining the process window for infinite Si_3N_4/CVD a-C etch selectivity. The etch results of patterned ArF PR/BARC (bottom anti-reflective coating)/SiOx/CVD a-C/Si_3N_4 MLR structure supported the possibility of using a infinitely high selective etch processes of the Si_3N_4 layer using CVD a-C etch-mask. Detailed mechanism for very high etch selectivity of Si_3N_4 layer to the CVD a-C layer will be discussed in detail.