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# Silicon Oxide and Silicon Nitride Etching in Inductive $NF_3/C_2H_4$ Plasma

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High-density low-pressure inductive plasma was used to study $SiO_2$ and $Si_3N_4$ etching with $NF_3/C_2H_4$-based feed gas chemistry. $NF_3$ and $C_2H_4$ were used so that fluorine and carbon, required for selective etching of silicon oxide over silicon nitride, can be supplied from parent gases other than strongly global warming fluorocarbons. Thus far, selective etching of $SiO_2$ over $Si_3N_4$ has not been achieved. Etch rates of $SiO_2$ over a wide range of conditions are roughly 0.6 to 0.8 of $Si_3N_4$ etch rates. Ex-situ X-ray photoelectron spectroscopy was employed to determine the characteristics of a very thin steady-state intermediary film, which controls reactions between the solid substrate and the plasma, and to establish likely etching mechanisms. The C1S spectrum from an etched oxide sample shows a large percentage of C-C bonding compared to other types of bonding for carbon atoms. For an etched nitride sample, the fraction of C-C type carbon bonds is much smaller than that in etched $SiO_2$. On the other hand, the fraction of more volatile CN groups is found to be significantly higher on an etched nitride surface. It appears that this behavior contributed to the higher etch rates of nitride compared to oxide. XPS measurements showing the effects of wafer bias frequency on the intermediary film are also presented.