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The characterization of low-*k* SiCOH etched film as a function of plasma power

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As integrated circuits (ICs) continue to shrink, their speed comes to be limited by their resistance × capacitance (RC) time constant, resulting in increased power dissipation and increased cross-talk in multilevel interconnects. It is necessary to replace the present interlayer dielectric SiO_2(a relative dielectric constant k~4.0) by materials with a low dielectric constant (low-k: $k \leq 3.5$). Many research groups are investigating the etching mechanism of low-k materials. Several research groups have reported observing plasma damage to blanket and patterned low-k dielectric films. However, to reach these goals, adjusting the standard plasma parameters (source power, bias voltage, gas mixture, pressure, etc) is not always sufficient. In this work, we reported the influence of top and bottom plasma power on the low-k SiCOH films in inductively coupled plasma (ICP) etching system. We have investigated the etch rate and electrical and chemical properties of low-k (k=2.8) SiCOH etched in CF_4/Ar(10%), and CHF_3/Ar(10%) plasmas as a function of inductively coupled plasma power. The power of top and bottom plasmas increased, the etch rate of low-k film increased. The higher etch rate was observed with CF_4/Ar than with CHF_3/Ar plasma. Surface and bulk properties of low-k film after etching were studied using surface analysis such as x-ray photoelectron spectroscopy (XPS) and Fourier Transform Infrared (FT-IR) Spectroscopy. The changed of the etch rate as a function of plasma power was correlated with the change of the FT-IR absorbance peaks of C-H_x and Si-O related groups. Surface roughness was investigated by AFM.

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Silicon oxy-nitridation using the hyperthermal neutral beam (HNB)

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Hyperthermal Neutral Beams (HNB) is drawing the attention for manufacturing future nanoscale devices owing to reducing the plasma-induced damage. We will present the characteristics of SiON films grown using the HNB with an energy of tens of eV for the gate dielectric material. The HNB generated by the inductively coupled plasma (ICP). The RF input power is 1500 W, the operating pressure less than 1 mTorr, the substrate temperature is 400 ℃, and the bias voltage of the neutralization plate in a range of 0 ~ -40 V. The electrical and physical properties are measured with a metal oxide silicon (MOS) structure: Current-Voltage (IV), Capacitance-Voltage (CV) characteristics and XPS, SIMS analysis. As a result, the SiON film leakage current is 1.0E-8 A/cm2 at 6.5 MV/cm. These results support that the HNB is an extremely good method to grow the SiON film without plasma-induced damage.