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Etching of high-k HfO_2 films in high-density chlorine-containing plasmas without rf biasing KOUICHI ONO, KEISUKE NAKAMURA, DAISUKE HAMADA, KAZUSHI OSARI, KOJI ERIGUCHI, Kyoto University — Plasma etching of high dielectric constant (k) films is indispensable for the fabrication of high-k gate stacks. This paper presents the etching of high-k materials of HfO_2 in high-density chlorine-containing plasmas excited by electron cyclotron resonance. Experiments were performed with BCl_3/Cl_2 mixtures at a pressure of 5 mTorr in the absence of rf biasing; under these conditions, the difference between the plasma and floating potentials was of the order of 10 V. In pure BCl_3 plasma, some deposition was found to occur on HfO_2 surfaces to inhibit etching. By adding Cl_2 to BCl_3, the deposition was suppressed to result in the etching of HfO_2. The HfO_2 etch rate increased with increasing Cl_2 concentration, giving the maximum HfO_2 etch rate of about 100 nm/min at 60% Cl_2. At lower Cl_2 concentrations of 25-50%, the HfO_2 etch rate was > 20 nm/min, while the Si etch rate remained almost zero, thus giving a high selectivity of $>> 50$ over Si. Moreover, by adding a small amount of O_2 to BCl_3/60%-Cl_2 plasma, the HfO_2 etch rate was found to increase to about 150 nm/min at 5% O_2, while the Si etch rate was also increased to deteriorate the selectivity over Si down to 4. The addition of Cl_2 and/or O_2 to BCl_3 would increase the concentration of Cl and decrease that of inhibitors BCl_x in the plasma. These results were compared with plasma and surface diagnostics, to understand plasma-surface interactions responsible for.

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