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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Date submitted: 16 Jun 2006