The surface kinetic properties of ZrO_2 Thin Films in dry etching by Inductively Coupled Plasma

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Abstract : ZrO_2 is one of the most attractive high dielectric constant (high-k) materials. As integrated circuit device dimensions continue to be scaled down, high-k materials have been studied more to resolve the problems for replacing the conventional SiO_2. ZrO_2 has many favorable properties as a high dielectric constant (k= 20~25), wide band gap (5~7 eV) as well as a close thermal expansion coefficient with Si that results in good thermal stability of the ZrO_2/Si structure. In order to get fine-line patterns, plasma etching has been studied more in the fabrication of ultra large-scale integrated circuits. The relation between the etch characteristics of high-k dielectric materials and plasma properties is required to be studied more to match standard processing procedure with low damaged removal process. Due to the easy control of ion energy and flux, low ownership and simple structure of the inductively coupled plasma (ICP), we chose it for high-density plasma in our study. And the $BCl_3$was included in the gas due to the effective extraction of oxygen in the form of BClxOy compound

In this study, the surface kinetic properties of ZrO_2 thin film was investigated in function of Cl_2 addition to BCl_3/Ar gas mixture ratio, RF power and DC-bias power based on substrate temperature. The figure 1 showed the etch rate of ZrO_2 thin film as function of gas mixing ratio of Cl_2/BCl_3/Ar dependent on temperature. The chemical state of film was investigated using x-ray photoelectron spectroscopy (XPS).The characteristics of the plasma were estimated using optical emission spectroscopy (OES). Auger electron spectroscopy (AES) was used for elemental analysis of etched surface.

Key Words : ZrO_2 Dry Etching; ICP; Surface kinetic

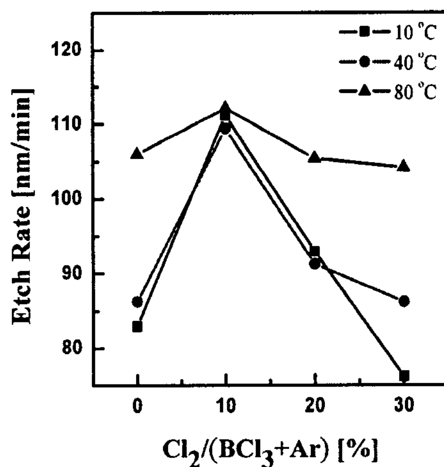

Figure 1 Etch rate of ZrO_2 thin film as function of gas mixing ratio of Cl_2/BCl_3/Ar dependent on temperature.