Effect of each plasma parameter on the high aspect ratio oxide etching process at low-frequency bias power using an inductively coupled plasma system

Hye Jun Son, Gilyoung Choi, and Kwang-Ho Kwon*

Department of Control and Instrumentation Engineering Korea University Sejong 30019, Republic of Korea

kwonkh@korea.ac.kr

In this study, the impact of ions, ion energy, and radicals on HAR oxide etch characteristics, which are important parameters of high aspect ratio (HAR) oxide etching, were investigated using low frequency (2 MHz) bias power in an inductively coupled plasma (ICP). First, the process was designed to primarily change only each of these parameters to determine the effect on the etch characteristics. In order to confirm this plasma characteristic change, plasma diagnosis was performed using double Langmuir probe (DLP) and active species analysis was performed using optical emission spectroscopy (OES). In addition, V_{DC} was investigated to confirm the energy change of ions. To confirm the effect of these plasma characteristics on the etching characteristics, X-ray photoelectron spectroscopy (XPS) analysis was also performed for surface analysis. At the same time, 100 nm (etch area)/500 nm (mask area) line patterns were used for the analysis of the etched profile using field-emission scanning electron microscope (FE-SEM) equipment.

In this work, we suggest that it is possible to obtain a vertical profile of the oxide in the ICP etching system because of higher V_{DC} at the low frequency (2 MHz) bias power, compared to the high frequency (13.56 MHz) bias power and very low process pressure at ICP system. Through these plasma parameter changes, we discussed the effect of each plasma parameter on the HAR oxide film etch characteristics in detail.