SiO$_2$ Film Etching Process Using Environment-Friendly New Gas C$_5$F$_7$H

YUDAI MIYAWAKI, KEIGO TAKEDA, Nagoya University, AZUMI ITO, MASAHIRO NAKAMURA, Zeon Corporation, MAKOTO SEKINE, MASARU HORI, Nagoya University — With the continuous miniaturization of semiconductor memory devices, a much precise etching process for a high aspect ratio contact hole in SiO$_2$ film is indispensable. Furthermore, deterioration of the SiO$_2$ selectivity over a fragile, thin ArF photoresist would cause the sidewall roughness and poor pattern-width definition. In this study, we utilized a newly designed C$_5$F$_7$H gas. We compared the etch performances between the new gas and conventional C$_5$F$_8$. Ar and O$_2$ were introduced with each fluorocarbon gas to control the etching rate. A dual frequency (60 MHz / 2 MHz) capacitively coupled plasma was employed. The SiO$_2$ etching rate and selectivity to ArF photoresist were investigated as a function of O$_2$ flow rate. The maximum selectivity of only 3.7 and the SiO$_2$ etching rate of 416 nm/min were obtained at O$_2$ flow rate of 20 sccm for the C$_5$F$_8$/O$_2$/Ar plasma. For the newly developed C$_5$F$_7$H/O$_2$/Ar plasma, the maximum selectivity of 13.5 with the etching rate of 356 nm/min was achieved at 25-sccm O$_2$ flow rate. From these results, it was confirmed that almost four times higher selectivity than that of the conventional C$_5$F$_8$ gas was obtained by using the new C$_5$F$_7$H gas.

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