Characterization of SiO_2 plasma etching with different liquid fluorocarbon precursor using quadrupole mass spectroscopy

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Fluorocarbons like C_2F_6, C_4F_8, CHF_3, and NF_3 are widely used for plasma etching process in the semiconductor industry. The fluorocarbons generally have high Global Warming Potential (GWP) and been considered to raise greenhouse effect. Regarding this issue, it is important to investigate etching process which produces gases with low GWP and shows competent etching quality compared with pre-existing precursor.

After the effort to find the precursor with low GWP, fluorocarbons mostly show the several orders of GWP magnitude larger than that of carbon dioxide. The precursors are almost exhausted from the plasmas into the atmosphere without dissociation because only a small fraction of gas species are ionized in the non-thermal plasmas. Considering this facts, it can be deduced that collecting the exhausted fluorocarbons from the end of exhaust is the efficient method to achieve both of low greenhouse effect and satisfactory etching quality.

In this study, liquid fluorocarbons are investigated as an alternative fluorocarbon precursor that have not been characterized to replace conventional PFC gases with high GWP. It is easily expected that the liquid precursors can be collected at end of exhaust. Using the C_7F_{14} and C_7F_8 as liquid fluorocarbon precursor, SiO_2 etching processes were performed in the capacitively coupled plasma etching process. And dissociative characterizations of the precursors were investigated using the quadrupole mass spectrometer (QMS). The etching rate and the etching selectivity of SiO_2 over resist are compared between C_7F_8 and C_7F_{14}. And The etching characteristics of the liquid precursor were compared with the conventional PFC gas. For more information about the results, the differences of the F/C ratio of the precursors, which was determined with QMS results are also investigated.

The dissociative characterizations of the precursors with increasing electron energy of QMS ionizer was also performed in plasma-off condition. This analysis method is enable to expect the etching characters of the liquid precursor.

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