A study on the high-aspect-ratio oxide etching characteristics using a Hexafluoroisobutylene with a low global warming potential

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In this study, high-aspect-ratio (HAR) oxide etching characteristics in inductively coupled plasma (ICP) was investigated using low frequency (2 MHz) bias power. For HAR oxide etching, a Hexafluoroisobutylene ($C_4H_2F_6$) with a low global warming potential of 18 was used, as an alternative gas for C_4F_8 gas. An experiment was conducted using CF_4/$C_4H_2F_6$(or C_4F_8) /He as the mixed gas. 100 nm (etch area)/500 nm (mask area) line patterns were used, and the etch cross section and etch selectivity of the amorphous carbon layer thin film were derived using a scanning electron microscope (SEM). Ion density was extracted using a double Langmuir probe, and CF_x and F neutral species were observed via optical emission spectroscopy. Furthermore, X-ray photoelectron spectroscopy and surface energy measurements were conducted for surface analysis. In this work, we extracted the very vertically etched profile of the high aspect ratio oxide patterns using $C_4H_2F_6$ gas chemistry at the ICP etching system. The etching characteristics of the oxide films was also investigated. Based on these results, the possibility for HAR oxide etching using $C_4H_2F_6$ gas chemistry was first suggested in this work. These results also indicate that the use of $C_4H_2F_6$ gas can significantly reduce global warming concerns and contribute to the development of next-generation HAR oxide etching process.