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Low Temperature Etching of Silicon Oxide using Ar/CF_4 Plasma

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Advanced memory devices have been developed with high aspect ratio (HAR) structures.[1] This increase in AR, however, leads to reduced etch rates in narrow and deep features.[2] This study investigates ways to improve etch rates by lowering temperature using Ar/CF_4 plasma in silicon oxide and silicon nitride. Chiller temperature adjusted from +20 °C to –40 °C.

Silicon oxide etch rate increased by 14 %, and silicon nitride etch rate increased by 15 % at –40 °C compared to room temperature. Etch selectivity of silicon oxide over ACL mask improved from 1.3 to 2.1. More physisorbed fluorocarbons, CF_3+ and CF_2+, were found at low temperature than at room temperature. Chemisorbed carbon (C1s) and fluorine (F1s) signals also increased at low temperature, as observed by X-ray photoelectron spectroscopy (XPS). Fluorocarbon layer thickness at –40 °C was 2.3 times greater than at room temperature and the F/C ratio also increased.

The increased etch rates were attributed to enhanced fluorocarbon adsorption at low temperatures. These results provide insight into temperature dependent fluorocarbon adsorption behavior in high AR etch applications.

References

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[2] M. Shen, et al, Jpn. J. Appl. Phys. **62**, (2023)

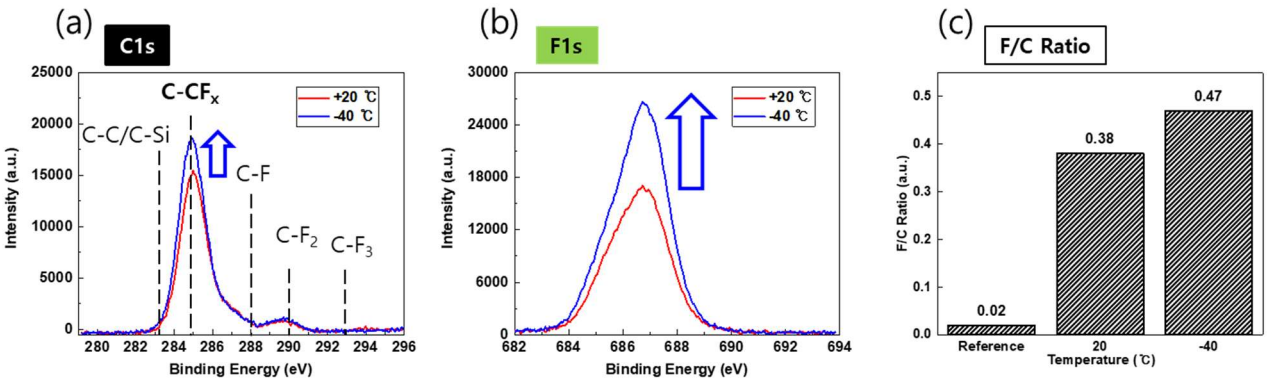

Figure 1. (a) Carbon and (b) fluorine peaks at XPS. (c) F/C ratio at SiO_2 surface after CF_4/Ar plasma exposure.