

パーフルオロエーテルの解離過程

CF_3^+ fragmentation by electron impact ionization of perfluoro- vinyl-ethers

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Introduction In plasma etching processes, the densities of chemically reactive species have attracted attention. A higher etch yield for SiO_2 at lower ion impact energies was reported when using CF_3^+ ions.[1] Perfluoro-vinyl-ether forming selectively CF_3^+ ions were reported.[2] Here we extensively studied in details the gas phase fragmentations of perfluoro-vinyl-ether.

Methods A quadrupole mass spectrometer (QMS; Hiden Analytical, EQP) was installed in the chamber wall of the commercial plasma etching reactor. PPVE ($\text{CF}_3\text{-CF}_2\text{-CF}_2\text{-O-CF=CF}_2$, $\text{C}_5\text{F}_{10}\text{O}$) or PMVE ($\text{CF}_3\text{-O-CF=CF}_2$, $\text{C}_3\text{F}_6\text{O}$) was introduced into the chamber and maintained at a pressure of 1.0 Pa.

Results and discussion Dissociative ionization caused by impact with 20 eV electrons provided positive ion fragmentation pattern to three peaks for PMVE: CF_3^+ , $\text{C}_2\text{F}_2\text{O}^+$ and $\text{C}_3\text{F}_6\text{O}^+$, and five peaks for PPVE: CF_3^+ , $\text{C}_2\text{F}_2\text{O}^+$, C_2F_5^+ , C_3F_7^+ and $\text{C}_5\text{F}_{10}\text{O}^+$. Figure 1 shows comparison of the ion efficiency for CF_3^+ between (a) PPVE and (b) an isomer of PMVE. The large ionization efficiency of CF_3^+ was experimentally observed significantly as the leading cause of large cross-sections for dissociative ionization of CF_3^+ ions. For comparison, the CF_3^+ ion density fragmented from perfluoro-alkanes is only 30 to 40%. By the energetic electron impact on the perfluoro-vinyl-ethers, excess energy is distributed among internal energies at the vinyl-ether bond, due to polarization of the charge on the bridging oxygen atom. The fragmentation via direct bond rupture into smaller product ions occurs more favorably than the rearrangement or cleavage into molecules with large mass.

References [1] K. Karahashi *et al.* J. Vac. Sci. Technol. A **22** 1166 (2004). [2] M. Nagai *et al.*, Jpn. J. Appl. Phys. **45** 7100 (2006); Y. Morikawa *et al.*, Jpn. J. Appl. Phys., **42**, 1429 (2003).

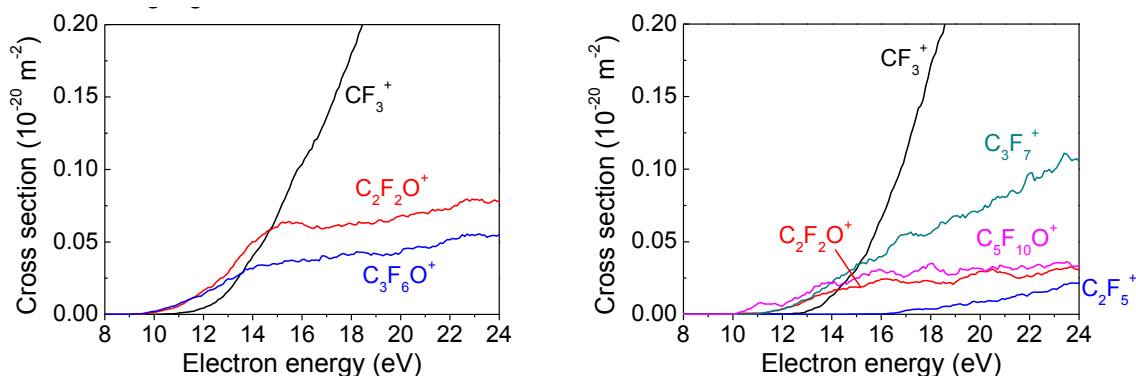


Figure 1. Ion efficiency curves for (a) PPVE and (b) PMVE.