

ELECTRONIC EXCITATION OF COF₂ AND C₃F₆ MOLECULES BY ELECTRON IMPACT

H. Kato¹, T. Tanaka¹, C. Makochekanwa^{1,2}, M. Kitajima¹, M. Hoshino¹, H. Cho³ and H. Tanaka¹

1) Department of Physics, Sophia University, Tokyo 102-8554, Japan

2) Graduate School of Sciences, Kyushu University, Fukuoka 812-8581, Japan

3) Physics Department, Chungnam National University, Daejeon 305-764, South Korea

COF₂ has been advocated as a suitable cleaning gas in the Chemical Vapor Deposition (CVD) equipment, used in various processes in the semiconductor industry, and has thus attracted a lot of attention. Compared with other conventional cleaning gases, its global warming potential is as small as a few tens of thousandths. However, little is known about the physical and chemical properties of this molecule. On the other hand, C₃F₆ is invaluable as an etching gas in plasma processing, due to its small global warming potential and a short atmospheric lifetime. However, although there have been some works on photoelectron spectroscopy on these molecules [1-2], there is almost no data on electron scattering.

The experimental apparatus consists of a typical cross-beam method in conjunction with the relative flow technique [3]. The experimental resolution was about 40 meV (FWHM). Electron energy loss spectroscopy (EELS) spectra of COF₂ were measured at 30 eV and 100 eV at the fixed angles of 10° and 5°, respectively, while sweeping the energy losses over the range 5 – 18 eV. EELS spectra of C₃F₆ were measured at 20 eV and 100 eV at the fixed angles of 10° and 5°, respectively, while sweeping the energy loss over the range 2 – 14 eV. Part of the results from this study is shown in Fig. 1.

In Fig. 1, the assignment of the observed broad features and the ionization potential (I. P.) for the 7.5 – 10.6 eV are from the VUV photoabsorption spectra of Ref. [2]. The second I. P. for the region 10.6 – 13.8 eV is from Ref. [4]. Three broad structures due to optically allowed transitions have been observed at about 7 eV and 7.5 eV and attributed to the C = C π → C – F σ*; C = C π → C = C σ* (both dissociative); and at 8.2 eV, due to C = C π → C = C π* excitations. The Rydberg states assignments shown at 7.5

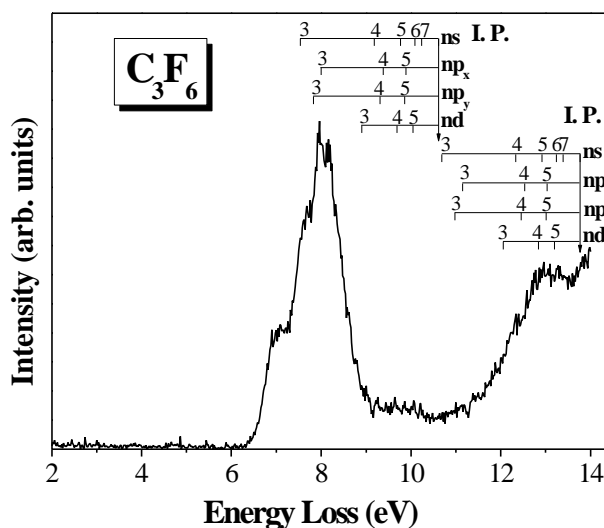


Fig. 1. EELS spectrum of C₃F₆ at the impact energy of 100 eV and angle of 5°.

– 10.6 eV are from Ref. [2], while we have assigned those at 10.6 – 13.8 eV using the standard Rydberg series equation and quantum defect values from Ref. [2]. Distinct differences have been observed in the EELS spectra above 11.5 eV between impact energies of 20 eV and 100 eV. Detailed discussions of these results and those for COF₂ will be presented at the conference.

This work was partially supported by the CUP program between Japan and South Korea. We also thank the Daikin Co. for kindly supplying us with the COF₂ gas sample.

References

- [1] Gary L. Workman and A. B. F. Duncan, *J. Chem. Phys.* **52**, 3204 (1970).
- [2] S. Eden *et al.*, *Chem. Phys. Lett.* **379**, 170 (2003).
- [3] H. Tanaka, *et al.*, *J. Phys. B* **21**, 1255 (1988).
- [4] B. S. Freiser and J. L. Beauchamp, *J. Am. Chem. Soc.* **96**, 6260 (1974).