Vacuum Ultraviolet Absorption of S2OF10

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Short Communication

Vacuum Ultraviolet Absorption of S_2OF_{10}

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Abstract. — Absorption coefficients k_0 (m^{-1} 100 kPa^{-1}) of S_2OF_{10}, a gaseous by-product of electrically stressed SF_6, were measured between 122 and 202 nm The experiments were carried out at a temperature of 298 K and a spectral resolution of 0 1 nm over the whole wavelength range The results complete those we previously published on SF_6, SF_4, SOF_2 and SO_2F_2 absorption in the same wavelength region [1].

Résumé. — Les coefficients d'absorption k_0 (m^{-1} 100 kPa^{-1}) du S_2OF_{10} qui constitue l'un des produits de décomposition gazeux du SF_6 soumis à des contraintes électriques ont été mesurés entre 122 et 202 nm Les expériences ont été réalisées à la température de 298 K avec une résolution de 0,1 nm sur toute la gamme de longueurs d'onde. Ces résultats complètent ceux que nous avons précédemment publiés sur l'absorption du SF_6, du SF_4, du SOF_2 et du SO_2F_2 dans le même domaine de longueurs d'onde [1].

We recently published absorption coefficients of sulfur hexafluoride (SF_6), which constitutes the most widely used insulating gas in high voltage apparatuses, and of its main gaseous by-products under coronas, sparks or arcs: sulfur tetrafluoride (SF_4), thionyl fluoride (SOF_2) and sulfuryl fluoride (SO_2F_2), in the wavelength range 115-200 nm [1].

The knowledge of these absorption spectra is essential for instance for arc modeling studies. Indeed, as in power arcs or sparks radiative transfer constitutes a particularly important mechanism, the absorption by the surrounding cold gas of the radiation emitted by the plasma results in an heating of this gas and therefore to a pressure increase which may have a strong influence on the circuit-breaker behaviour.

In addition to SF_4, SOF_2 and SO_2F_2 other gaseous compounds are formed in much smaller quantities when SF_6 is subjected to electrical discharges, this is the case, for example, of disulfur decafluoride (S_2F_{10}), pentafluorosulfur oxide (S_2OF_{10}), bis(pentafluoro-sulfur)peroxide ($S_2O_2F_{10}$) and $S_2O_3F_6$ [2–6].

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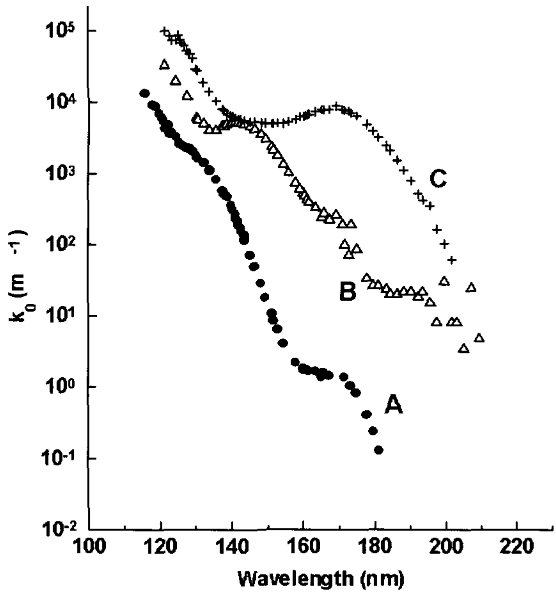

Fig. 1. — Comparison of the measured absorption coefficient k_0 for S_2OF_{10} (curve C) with that of SF_6 (curve A) and that of SO_2F_2 (curve B). The k_0 values for SF_6 and SO_2F_2 are taken from reference [1]. The k_0 values are given for a gas pressure of 100 kPa.

Among these compounds, S_2OF_{10} proved to be particularly stable [4] and we were thus able to complete a previous study [1] with the absorption data for this compound between 122 and 202 nm. S_2OF_{10} was specially prepared for us by a University Laboratory and its purity was found to be higher than 99.8%.

The absorption measurements were carried out at several S_2OF_{10} pressures ranging from 7 Pa to 10^2 Pa for wavelengths between 122 and 145 nm and from 50 Pa to 5×10^3 Pa for the 140-202 nm wavelength range using the same apparatus as that described in reference [1] and in the same experimental conditions: $T = 298 \pm 2$ K; a spectral resolution of 0.1 nm over the whole wavelength range; an uncertainty on the wavelength values of ± 0.05 nm.

The absorption coefficient k_0 was calculated from Beer-Lambert's law:

$$I = I_0 \exp\left(-k_0 \frac{P}{P_0} d\right)$$

I_0 and I being the incident and the transmitted photon beam intensities respectively at a wavelength λ and temperature T; d the path length ($d = 13.6$ cm); $P_0 = 10^5$ Pa and P the absolute pressure in the absorption cell in Pa.

The k_0 values of S_2OF_{10}, deduced from the slopes of the plots of ln (I_0/I) *versus* P for the different wavelengths studied are displayed in Figures 1 and 2 where they are compared to those of the purest SF_6 we studied and of SO_2F_2 or SOF_2 respectively taken from the previous paper [1]. The uncertainty on the S_2OF_{10} absorption coefficients was estimated to be about $\pm 10\%$ for the highest and the lowest values and about $\pm 6\%$ for the others.

From Figure 1 it can be seen that S_2OF_{10} presents a greater absorption than SO_2F_2 and particularly than SF_6 with values of k_0 ranging from 9.9×10^4 m^{-1} (for $\lambda = 121.6$ nm) to 61 m^{-1} (for $\lambda = 201.8$ nm) with a peak at 169.5 nm ($k_0 = 8.8 \times 10^3$ m^{-1}).

The overall absorption spectrum of S_2OF_{10} however is quite similar to that of SOF_2 (see Fig. 2) and even SF_4 (see Fig. 5 of Ref. [1]).

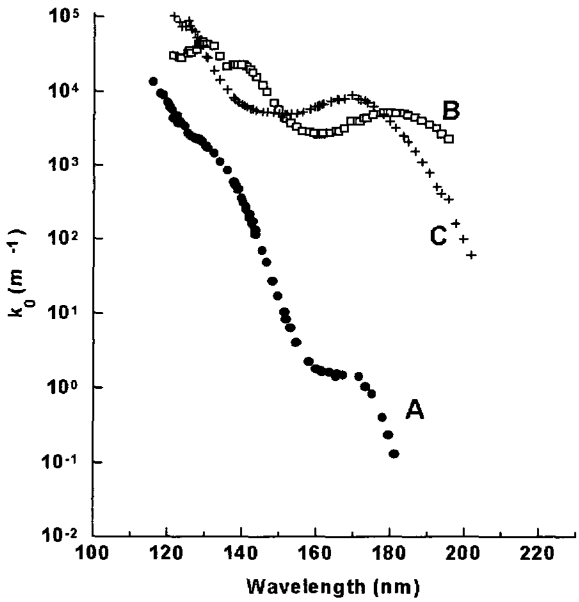

Fig. 2. — Comparison of the measured absorption coefficient k_0 for S_2OF_{10} (curve C) with that of SF_6 (curve A) and that of SOF_2 (curve B). The k_0 values for SF_6 and SOF_2 are taken from reference [1] The k_0 values are given for a gas pressure of 100 kPa.

Acknowledgments

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References

[1] Pradayrol C., Casanovas A. M., Deharo I., Guelfucci J P. and Casanovas J., Absorption coefficients of SF_6, SF_4, SOF_2 and SO_2F_2 in the vacuum ultraviolet, *J. Phys. III France* **6** (1996) 603.

[2] Castonguay J. and Dionne I., S_2F_{10} and other heavy gaseous decomposition by-products formed in SF_6 and SF_6-gas mixtures exposed to electrical discharges, 7th Int Symp. on Gaseous Dielectrics (Knoxville, April 24-28, 1994), paper 61.

[3] Piemontesi M. and Niemeyer L., Generation and decay of $S_2O_2F_{10}$ in SF_6 insulation, Proc. 9th Int. Symp. on High Voltage Engineering (Graz, August 28-September 1, 1995) pp. 2284-1-2284-4.

[4] Pradayrol C., Casanovas A.M., Hernoune A. and Casanovas J., Spark decomposition of SF_6 and $SF_6 + 50\%\ CF_4$ mixtures, *J. Phys. D : Appl. Phys.* **29** (1996) 1941.

[5] Van Brunt R J , Olthoff J.K., Firebaugh S.L and Sauers I., Production of S_2F_{10}, S_2OF_{10}, and $S_2O_2F_{10}$ from spark and negative-corona discharges in SF_6 and SF_6/O_2 gas mixtures, *Trans. IEE Japan* **116-A** (1996) 1014.

[6] Pradayrol C., Casanovas A.M., Aventin C. and Casanovas J., Production of SO_2F_2, SOF_4, (SOF_2+SF_4), S_2F_{10}, S_2OF_{10} and $S_2O_2F_{10}$ in SF_6 and (50-50) SF_6-CF_4 mixtures exposed to negative coronas, *J. Phys. D : Appl. Phys.* **30** (1997) 1356.