1C4b Detection of Atomic Oxygen O(^{3}P) with Vacuum Ultraviolet Emission Subsequent to Two-Photon Excitation

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Atomic oxygen plays important roles in the chemical processes in the atmosphere, combustion, and plasma. Highly sensitive detection of atomic oxygen is a key to elucidate the mechanism of the processes. Observation of infrared emission following two-photon absorption has been widely employed to detect atomic oxygen so far.[1,2] The detection sensitivity, however, is not high because of the low detectability of infrared radiation, and the detection limit of number density is $\approx 10^{13}$ cm^{-3}. In the present study, a new method of detecting vacuum ultraviolet (VUV) instead of infrared emission has been developed.

A gaseous mixture of O_3 and Ar in a flow cell at 298 K was irradiated with light at 248 nm from a KrF laser. O(^{1}D) generated in the photolysis of O_3 underwent the following quenching and reactions.

$$O(^1D) + Ar \rightarrow O(^3P) + Ar \qquad (1)$$

$$O(^1D) + O_3 \rightarrow 2O(^3P) + O_2 \qquad (2a)$$

$$\rightarrow O(^3P) + O_3 \qquad (2b)$$

$$\rightarrow 2O_2 \qquad (2c)$$

O(^{3}P) as the products of channels 1, 2a, and 2b was detected by two-photon laser-induced fluorescence (2P-VUV LIF) technique whose scheme is shown in Fig. 1. Fig. 2 shows the observed spectrum corresponding to the transitions from the three J-levels of the ground state (2p^4 ^3P_J) to the excited state (2p^{3}3p ^3P_J). The estimated relative intensity 10.00/1.68/0.13 for J = 2/1/0 based on the two-photon absorption two-photon absorption cross sections and Boltzmann distribution is in excellent agreement with those observed. The present method has improved the detection limit to $\approx 10^{10}$ cm^{-3} which is superior to the conventional method by about 3 orders of magnitude.

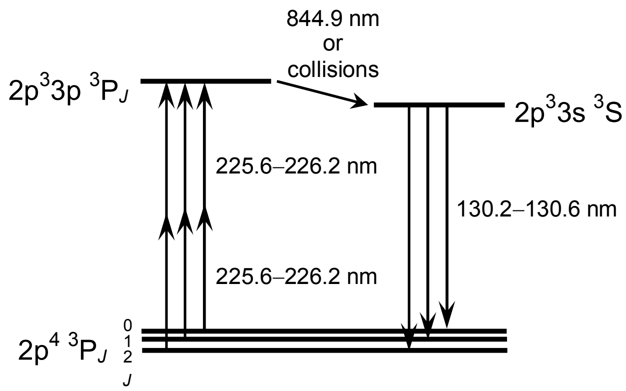

Fig. 1. Scheme of 2P-VUVLIF for detection of atomic oxygen O(^{3}P).

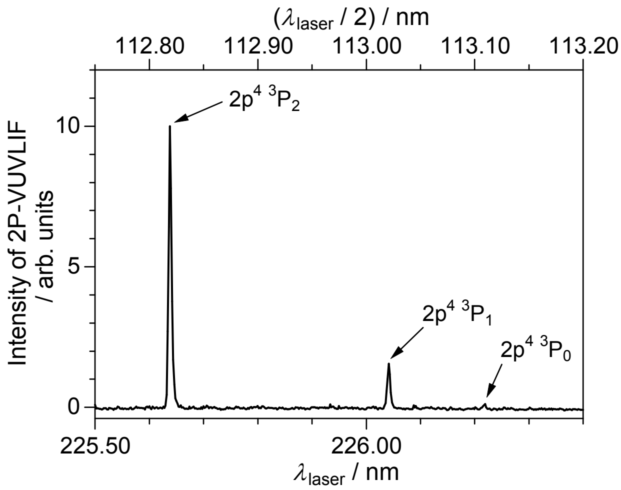

Fig. 2. Excitation spectrum of 2P-VUVLIF of O(^3P_J) with J = 0, 1, and 2. $p(O_3)$ = 2.9 mTorr, p(Ar) = 96 Torr.

References

1. Shaw, D. ; et al. *Plasma Sources Sci. Technol.* **2016**, *25*, 065018.
2. Schmidt, J. B. ; et al. *J. Phys. D: Appl. Phys.* **2017**, *50*, 015204.