Detection of H atoms by 2-photon LIF technique and Its Application to Chemical Kinetics

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Hydrogen atom is a constituent element of various chemical species and concerned with many reactions. The yields of H atoms enable us to elucidate the mechanisms of chemical reactions. We have constructed a highly sensitive detection system of H atoms and applied it to the kinetic studies on several chemical reactions.

A schematic diagram of the detection system is shown in Fig. 1. It consists of a MgF_2 focusing lens, optical interference filter for the Lyman-α radiation, and VUV photomultiplier tube (PMT). The detection scheme is: (i) H atom in 1s(^{1}S) state is excited to 2s(^{2}S) state by two photons at 243.2 nm from a dye laser; (ii) The 2s(^{2}S) state is transferred to 2p(^{2}P) state by collisions with ambient gases; (iii) Lyman-α emission, 2p(^{2}P) → 1s(^{1}S), at 121.6 nm is detected with the PMT. The 2-photon LIF excitation spectrum of H atoms generated in the photolysis of NH_3 at 193 nm is shown in Fig. 2.

Fig. 3 shows the time profiles of H atoms generated in a gaseous mixture $O_3/H_2/CO/He$ irradiated with a light at 266 nm. H atoms produced in a reaction OH(v) + CO → H + CO_2 following O(^{1}D) + H_2 → OH($v \leq 4$) + H were detected, and the time-resolved LIF intensities of H atoms were recorded as a function of the delay times between the photolysis and probe laser. The time profiles of H atoms generated in the reaction OH(v) + CO [Fig. 3(c)] is well-reproduced by simulation with the rate coefficients obtained in the analysis of the time profiles of OH(v = 0 – 4).

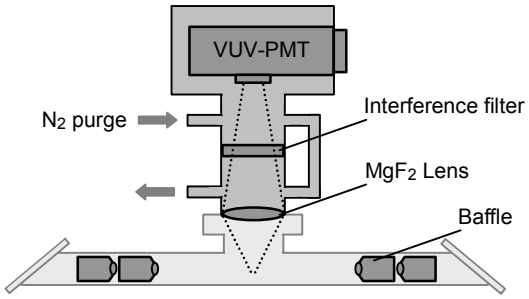

Fig. 1. A schematic diagram of the detection system of H atoms.

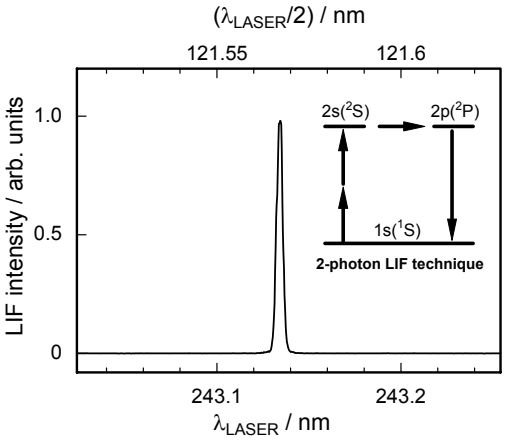

Fig. 2. 2-photon LIF excitation spectrum of H atoms. $P(NH_3)$ = 5 mTorr, P(He) = 10 Torr. The inset shows the scheme of detection.

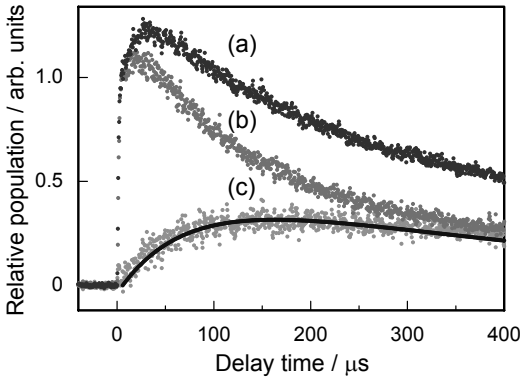

Fig. 3. Time-resolved LIF intensities of H atoms. $P(O_3)$ = 0.2 mTorr, $P(H_2)$ = 150 mTorr, P(He) = 10 Torr. (a) P(CO) = 400 mTorr and (b) P(CO) = 0 mTorr. (b) subtracted from (a) leaves (c). The black line denotes the results of simulation.