Photodesorption and CO_2 formation induced by 157 nm irradiation to CO on water ice

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Photodesorption of CO is suggested as a possible process which maintains a measurable amount of gaseous CO in cold interstellar clouds, where thermal desorption is negligible. Observations have indicated that the water-rich ice layer forms first on the grain and that most CO ice is present on top of the water ice [1]. Previous study indicates that there are two types of CO adsorption sites, free hydroxyl groups and oxygen atoms of surface coordinately unsaturated water molecules [2]. UV-induced CO_2 formation using CO/H_2O binary ice was reported [3]. However, the effect of adsorption states of CO on CO_2 formation has not been studied. In this study, we have investigated 157 nm photodesorption of CO on water ice at 8 K by measuring the time-of-flight (TOF) spectra of CO (v=0) detected by (2+1) resonance enhanced multiphoton ionization technique. Using the reflection absorption infrared (RAIR) spectroscopy, adsorption sites of CO on water ice and photoproducts was measured.

Figure 1 shows typical TOF spectrum of CO from 0.15 ML CO on water ice at 8 K. Measured spectrum could be characterized by a combination of three different Maxwell-Boltzmann distributions. It was described by a fast component (A) with T_{trans} = 1700 ± 300 K, a middle component (B) with T_{trans} = 450 ± 100 K and a slow component (C) with T_{trans} = 100 ± 30 K. The result indicates that there are three possible processes for photodesorption. Figure 2 shows RAIR spectra after 2, 6, 10 × 10^4 shots of 157 nm irradiation to 0.4 ML CO on water ice at 8 K. The peak is attributed to CO_2. CO_2 was produced via the reaction of CO with OH radical which was generated by photodissociation of water ice. In this presentation, we evaluate the possible link between adsorption sites of CO and CO_2 formation induced by 157 nm irradiation.

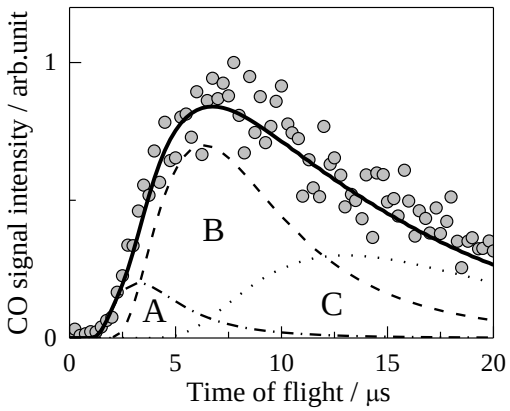

Figure 1: TOF spectrum of photodesorbed CO (v=0) from 0.15 ML CO on water ice.

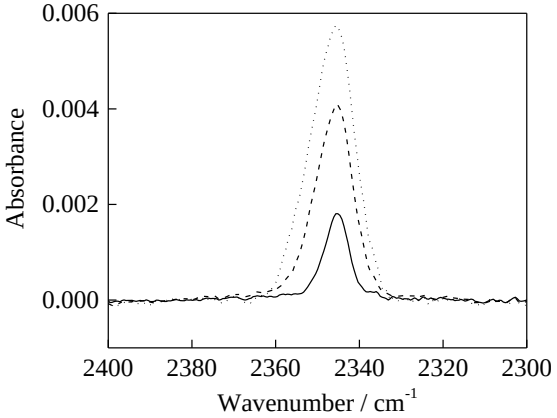

Figure 2: RAIR spectra measured after 2 (solid), 6 (dashed), 10(dotted) × 10^4 shots of 157 nm irradiation to 0.4 ML CO on water ice.

References

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[3] N. Watanabe and A. Kouchi, 2002, Astrophys. J., 567, 651.