

An (e, 2e + ion) study of low-energy electron-impact ionization and fragmentation of carbon dioxide

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Synopsis We study the ionization and fragmentation of carbon dioxide (CO₂) induced by low-energy ($E_0 = 66$ eV) electron-impact using a reaction microscope. The momentum vectors of all three charged final state particles, two outgoing electrons and one fragment ion, are detected with an (e, 2e + ion) triple coincidence method. The fragmentation pathways of carbon dioxide for formation of the CO₂⁺, CO⁺, O⁺ and C⁺ ions are investigated by measuring the ion kinetic energy spectra and the binding energy spectra where a binding energy resolution of 2.0 eV has been achieved in the experiment.

Electron-impact ionization of atoms and molecules is of fundamental importance in a wide range of scientific and practical applications. For molecular targets, the ionization process may populate dissociative states and result in neutral and positively charged fragments. As one of the fundamental constituents in planetary atmospheres, carbon dioxide (CO₂) has also been widely used in laser and gas discharge plasmas. Here, we investigate the processes of low-energy ($E_0 = 66$ eV) electron impact-induced ionization and ionic fragmentation of carbon dioxide (CO₂).

The observed reaction channels in the present low-energy electron-impact ionization and fragmentation of CO₂ are shown in Figure 1. The momentum vectors of all three final state charged particles, two outgoing electrons and one fragment ion, are detected in a (e, 2e + ion) triple coincidence method using a reaction microscope and a pulsed photoemission electron beam [1, 2]. The dissociated ions are usually created with higher kinetic energies than non-dissociated ions. Therefore, in order to cover a large solid angle for the detection of the fragment ions, the electric field is pulsed to about 15 V/cm for ion extraction. The electrons are measured by using lower electric field (1 V/cm) to obtain a better electron energy resolution. In the present work, the electron binding energy resolution of $\Delta E = 2.0$ eV has been obtained. Here, the binding energy is

defined as the initial projectile energy minus the sum energy of the two final state electrons. The fragmentation pathways of CO₂ for formation of the CO₂⁺, CO⁺, O⁺ and C⁺ ions are investigated by the measured ion kinetic energy spectra and the electron binding energy spectra [2, 3]. In addition, we also measured the (e, 2e) differential cross sections for the individual molecular orbitals and the different fragmentation channels. A detailed analysis of the ionization and fragmentation processes of CO₂ will be presented at the conference.

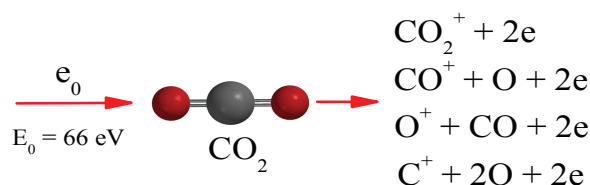


Figure 1. The reaction channels for the present low-energy electron-impact ionization and fragmentation of CO₂.

References

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