High-Resolution Measurements of Total Cross Section for Very-Low-Energy Electron Collisions with Molecules

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Accurate absolute cross section data for electron scattering from atoms and molecules provide important information not only for the fundamental physics of electron collisions but also for many fields such as electron-driven processes in the Earth and planetary phenomena, gaseous discharges, radiation chemistry and plasmas physics. Consequences of several interesting scattering phenomena such as Ramsauer-Townsend effect, shape resonances, vibrational Feshbach resonances, and threshold structure due to a virtual state, appear in the scattering cross section curves especially at very-low collision energies.

Beam experiments with hot-filament electron sources under the single collision condition have provided accurate cross-sections in a wide energy region, even in the energy range below a few hundred meV [1,2], where producing an electron beam at this very-low-energy region was a formidable task using the conventional technique. An alternative method which makes use of photoelectrons produced with the photoionization of atoms using Synchrotron Radiation (SR) source realized the measurements of electron scattering cross sections at very-low energies down to below 10 meV [3] in the single collision condition.

In the present report, results of our recent high-resolution measurements of absolute total cross sections for electron scattering from some small molecules obtained with a technique employing the threshold-photoelectron-source combined with SR [4] are presented. Onsets for some of the vibrational excitation thresholds showed up in the measured total cross section for CO_2, N_2O and CH_4. Integral vibrational excitation cross sections for CH_4 determined from the obtained total cross section were compared with the ones estimated from the swarm experiments [5] which showed reasonable agreements. The total cross section for CO_2 obtained at very-low-energies in the present study agree with those reported by Field et al [6], which showed larger cross section compared to the results of TOF measurements employing a hot-filament [7,8] at around 100 meV. We also note that although the results of Jones et al. showed significant discrepancy from the other earlier works [9] the present total cross section for NH_3 agreed well with those reported by Jones et al. down to the very-low-energies below 30 meV.

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