Total cross section for low-energy electron scattering from formic acid, (HCOOH), molecules

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Synopsis Total cross section (TCS) for low-energy electron scattering from formic acid molecules has been measured using electrostatic electron spectrometer working in linear transmission mode. Two local maxima centered around 1.7 eV and 7.8 eV have been observed and associated with resonant scattering processes.

Reliable, accurate experimental data concerning electron collisions with atoms, molecules or their clusters are of great importance in many fields of pure and applied science, ranging from space sciences, astrobiology, radiation physics and chemistry to gaseous electronics, energy conversion and electron impact-induced reactions on surfaces. In this work, we present our experimental studies on electron collisions with formic acid, (HCOOH), molecules.

The absolute total cross section (TCS) for electron scattering from HCOOH molecules has been measured using the electrostatic 127° electron spectrometer working within the linear transmission configuration [1] for impact energies ranging from 0.5 eV up to 300 eV. In this experimental setup the target sample in the scattering cell is irradiated with a monoenergetic electron beam (fwhm $\simeq$ 50 meV). Those electrons which emerge from the reaction region through a cell exit orifice are energy discriminated with a planar retarding field filter and, finally, electrons are collected with a Faraday cup detector. The total cross section $\sigma(E)$ at given electron impact energy E has been obtained according to the Bougue–de Beer–Lambert attenuation formula:

$$I_n(E) = I_0(E)\exp\left[-nL\sigma(E)\right]. \qquad (1)$$

Here, $I_n(E)$ and $I_0(E)$ are the measured intensities of the electron beam passing the distance L through the reaction volume in the presence or absence of the target vapor, respectively; n is the number density of the target molecules in the scattering cell.

The TCS obtained in the present experiments, for impinging electron energies ranging from 1 to 30 eV, is shown in figure 2 together with experimental total [2] and elastic [3] cross sections. In the presented energy range, TCS function is characterised by two resonant like features located near 1.7 eV and 7.8 eV, respectively. Both of them are connected with dissociative electron attachment processes which lead to production of three anionic fragments: $HCOO^-$ at 1.3 eV, OH^- at 7.8 eV and O^- at 7.5 eV and 9 eV [4].

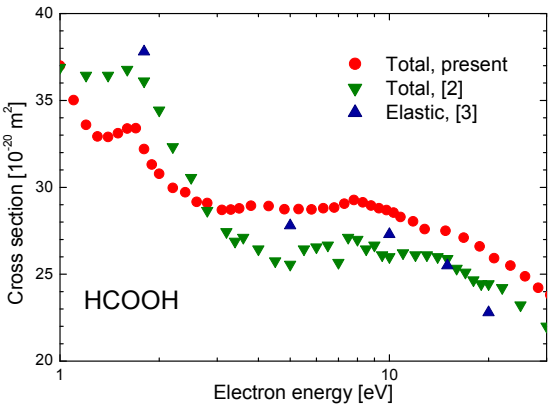

Figure 1. Comparison of the experimental cross sections for electron collisons with HCOOH molecule

Below 1.5 eV TCS function is increasing with energy decreasing, which is typical behaviour for electron collisions with polar molecules (dipole moment of formic acid $\mu_D = 1.41$D). While the data of Kimura *et al* [2] shows the same energetic dependence, with both resonant features clearly visible, as in the present results, some discrepancies in magniudes of both data sets can be easily observed.

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References

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