

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

Paweł Możejko^{*1}, Alicja Domaracka^{†2}, Mateusz Zawadzki^{*}, Elżbieta Ptasńska-Denga^{*} and Czesław Szmytkowski^{*}

^{*} Department of Atomic, Molecular and Optical Physics, Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, ul. G. Narutowicza 11/12, 80-233 Gdańsk, Poland

[†] Centre de Recherche sur les Ions, les Matériaux et la Photonique, Normandie University, ENSICAEN, UNICAEN, CEA, CNRS, CIMAP, F-14000 Caen, France

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, astrophysics, 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 \approx 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 Bouguer–de Beer–Lambert attenuation formula:

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

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 disso-

ciative 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].

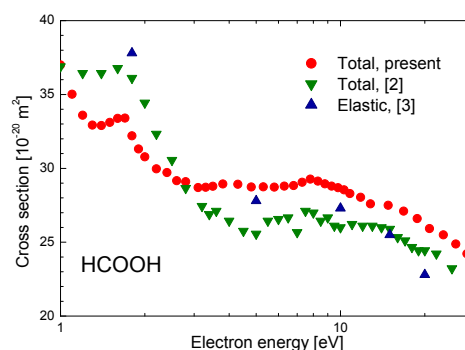


Figure 1. Comparison of the experimental cross sections for electron collisions with HCOOH molecule

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 $\mu_D = 1.41\text{D}$). 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 magnitudes of both data sets can be easily observed.

This work has been partially supported by the Polish Ministry of Science and Higher Education.

References

- [1] Cz. Szmytkowski and P. Możejko 2001 *Vacuum* **63** 549 635 001001
- [2] Kimura, M., O. Sueoka, A. Hamada, and Y. Itikawa 2000 *Adv. Chem. Phys.* **111** 537
- [3] V. Vizcaino, M. Jelisavcic, J. P. Sullivan and S. J. Buckman 2006 *New J. Phys.* **8** 85
- [4] A. Pelc, W. Sailer, P. Scheier, N.J. Mason and T.D. Märk 2002 *Eur. Phys. J. D* **20** 441

¹E-mail: paw@mif.pg.gda.pl

²E-mail: Alicja.Domaracka@ganil.fr

