Publ. Astron. Obs. Belgrade No. 103 (2024), 194 *Topical Invited Lecture*
https://doi.org/10.69646/aob103p194

ELECTRON SCATTERING CROSS SECTIONS OF 1,1,1,2-TETRAFLUOROETHANE (R134a)

MARNIK METTING VAN RIJN[1], STEPHEN F. BIAGI[2] and CHRISTIAN M. FRANCK[1]

[1]*Institute for Power Systems and High Voltage Technology, ETH Zurich, 8092 Zurich, Switzerland*
E-mail corresponding author: marnikm@ethz.ch

[2]*Faculty of Arts and Sciences Physics Department, Uludag University, Bursa, Turkey*

Abstract. The standard mixtures operating in resistive plate chambers at CERN primarily consist of the refrigerant R134a (CF_3CH_2F). The presence of a high-energy particle in the detector induces an electron avalanche, which can numerically be simulated using electron-molecule scattering cross sections. In this contribution (Metting van Rijn et al. 2024), a revised set of cross sections of R134a is presented, enabling more accurate detector-performance simulations for the standard mixtures.

Electron-transport coefficients obtained in swarm experiments are crucial when deriving cross sections since they provide experimental verification in terms of absolute values. The Pulsed Townsend experiment is an established experimental technique and allows measuring the electron drift velocity, the longitudinal diffusion, and the effective ionization rate. The presented R134a cross sections were derived from swarm measurements performed in pure and argon-diluted mixtures. To ensure consistency with Monte-Carlo simulations (Biagi 1999), the electron-transport coefficients were extracted following a rigorous theoretical framework (Casey et al. 2021). Previously acquired R134a data (Urquijo et al. 2009) was translated correspondingly.

The bulk-drift-velocity measurements in pure R134a were used to fit the elastic cross section. The energy thresholds in the vibrational excitations were taken from the Computational Chemistry Comparison and Benchmark Data Base. The position of the first vibrational resonance was reduced to lower energy in comparison to the previous R134a set. The reduction led to better agreement with the bulk-drift-velocity measurements in the argon mixtures. No modifications were applied to the dipole-allowed electronic excitations and the ionization since oscillator strengths and experimental data on the ionization are not available. The triplet excitations were varied in amplitude to fit the effective ionization rate. The large experimental uncertainty on the longitudinal diffusion did not allow any constraints on the cross-section fitting.

The derived set of cross sections agrees with the experimental swarm data in certain energy regimes. At thermal and high energies, the presented R134a set reproduces the data only qualitatively. The deviations most likely stem from either underestimating the experimental uncertainties or inaccurate measurements. Especially, the high-electric-field measurements are particularly challenging, since bandwidth limitations may obscure the induced signals resulting from short electron-transit times. Investigations on the significance of boundary effects in low-pressure measurements are further required.

References

Biagi, S.F. : 1999, *NIM-A,* **421(1-2)**, 234–240
Casey, M., et al. : 2021*, Plasma Sources Science and Technology*, **30(3)**, 035017.
Metting van Rijn, M., et al. : 2024, *Journal of Physics D: Applied Physics,* in press
Urquijo, J. et al. : 2009, *The European Physical Journal D*, **51**, 241–246.