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Determination of the electron scattering cross section set in tetrafluoroethane (C2H2F4) based on measurements of electron transport coefficients

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One of the most significant goals of swarm physics is determination of the charged particle scattering cross sections based on the available, transport data, such as drift velocity (W) and effective transverse characteristic energy (DT /μ). The first coefficient is the most sensitive to the elastic momentum transfer cross section, and the latter to the energy balance. This fact enables us to renormalize the existing cross sections on the basis of newly measured transport data [1], and also to predict the effective inelastic energy losses that are missing from the cross section sets available in the literature.

In this study we have used drift velocities and effective ionization coefficients ((α-η)/N) measured by the Pulsed Townsend technique in pure C2H2F4 and in mixtures of five different abundances (from 2% to 50% of C2H2F4 in Ar). The initial photoelectrons are released from the aluminum cathode by a UV pulse of a Nd:YAG (355 nm) laser. The displacement current produced by the electrons and ions is measured with a transimpedance amplifier (40 MHz, 105 V/A). The electron drift velocity is calculated as the time elapsed between the half-height of the leading and trailing edges of the measured electron current, which is

I_e(t)=(n_0 q_0/T_e) exp[(alpha-eta)v_e t] (1)

The calculations of the corresponding transport coefficients were performed by using two computer codes and the initial cross section set was that of S. Biagi, from the NIST database, which was mainly based on extrapolations from the C2F6 set. The first code solves the Boltzmann equation in a two-term approximation, and it was used only for numerous runs in the process of adjusting the cross sections. The second code was based on a Monte Carlo simulation technique, and because of its ability to obtain data without implicit limitations it was used for the final calculations.

The results of our investigations are shown in Figure 1. The final set required modifications of the momentum transfer cross section and the attachment cross section to become consistent with the experimental results for the pure gas. However, energy balance is not determined accurately due to the limited availability of data. Fitting C2H2F4 – Ar mixtures with small abundances of C2H2F4 could provide a better check on the energy balance while momentum balance for the mixture would mostly be controlled by Ar. Nevertheless, the present set can be used for modeling plasmas and gas discharges including particle detectors containing sufficiently small amounts of C2H2F4.

[1] De Urquijo J, Juárez A M, Basurto E and Hernández-Ávila J L 2009 Eur. Phys. J. D 51 2 241

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