RATE COEFFICIENTS FOR VIBRATIONAL EXCITATION OF CF_4 IN CROSSED RF ELECTRIC AND MAGNETIC FIELDS

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Knowledge of electron transport coefficients as well as detailed understanding of the kinetic phenomena that may occur in rf plasma are two basic demands in plasma modeling nowdays [1]. Transport coefficients obtained under conditions of crossed RF electric and magnetic fields are the input data necessary for fluid models of plasma reactors such as ICP (inductively coupled plasmas). In particular, the behaviour of the transport coefficients is important for a fundamental understanding of processes leading to RF plasma maintenance. However, modeling of RF plasmas often relies on application of DC swarm data. Hence, there are some critical steps in plasma modeling. Apart from the application of time resolved fields in our calculations another critical step is proper inclusion of the effects of magnetic field as well as adequate treatment of the electron transport which is non-local in space and not fully relaxed in time.

The aim of this work is to investigate behavior of the rate coefficients for vibrational excitation under the influence of crossed RF fields in pure CF_4. CF_4 is one of the most frequently used gases in plasma applications in ultra large scale integrated (ULSI) circuit technologies. Therefore, a great effort has been made in order to complete sets of cross sections and related electron swarm data in order to employ them in plasma modeling [2,3]. The structure of cross section with the predominant inelastic electron scattering process at low energy range require non-trivial treatment of the electron transport. Rapidly rising cross section for vibrational excitation in the region of Ramsauer-Townsend minimum induce a strong anisotropy of the electron velocity distribution function (EVDF) and the most common techniques employed for calculating the electron transport parameters in plasma modeling may fail. Therefore the only recourse for CF_4 is the exact techniques such as the multi-term theory for solving the Boltzmann equation or Monte Carlo simulations.

Our calculations based on Monte Carlo simulation technique show that the effect of the magnetic field is strong and consequently produces complex behavior of the electron swarm transport coefficients and kinetic phenomena that should be accounted for in plasma models. In particular, we show the rate coefficients for vibrational excitation in order to analyze and understand electron kinetics at the region of Ramsauer-Townsend minimum.

References

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