influence of ambipolar electric field on the EDF formation and the electron processes in gas discharge plasmas

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The local approximation is usually used for the calculation of the electron distribution function (EDF) in plasma. This means that the terms corresponding to spatial gradients and to the ambipolar field can be omitted in the Boltzmann equation and EDF can be factorized as (see, f.e. [1])

  (1)

The spatial diffusion can be neglected when the following conditions is fulfilled (see, f.e. [1])

 , (2)

where *L*  is the characteristic plasma dimension,  is the energy relaxation length.

Nevertheless, it is not clear that ambipolar field can be omitted in the kinetic equation. The ambipolar electric field is spatially no uniform and is small at the center of plasma and it presents significant growth at the plasma periphery. In case of quadratic dependence of ambipolar potential  in the central region of the gas discharge ( electric potential difference between center and wall), ambipolar field  is larger than the heating field  at the small distances, where

  (3)

On the other hand, the kinetic equation contains total electric field at a given point. In other words, electrons "feel" total electric field which is sum of heating, ambipolar, high-frequency etc. This means that at the distances  (3), where, applicability of the LA seems to be ambiguously.

In the present work, it is shown that use of local approximation for calculations of different characteristics in the gas discharge plasmas results in inaccuracies and mistakes at the periphery of gas discharge for high pressure plasmas and in whole plasma volume at low pressures.

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References

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