EFFECT OF THE LOADED ELECTRODE CONSTANT BIAS VOLTAGE ON ION ENERGY IN CAPACITIVE RF DISCHARGE IN EXTERNAL MAGNETIC FIELD

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Different modifications of DC discharge placed in external magnetic field with predominant radial component are well known nowadays and find extensive employment as a working process in electric Hall thrusters [1]. In works [2, 3] the possibility of acquiring accelerated ion beam in ion source with geometry of Hall thruster but DC discharge substituted by capacitive RF discharge in an external magnetic field with predominant radial component was researched. Anode of Hall thruster served as an active electrode, while thruster’s metal hull was grounded electrode. It was shown in works [2, 3] that usage of closed or open to DC electrical circuit of an active electrode allows to get ion beams with mean energies of approximately 70 and 200–300 eV respectively. However, ability to independently control ion density and mean energy in beam appeared to be limited. In present work in order to cope with this disadvantage combined capacitive RF and DC discharge was proposed as a working process of the ion source. It was supposed that RF power will allow to control ion beam density while anode DC bias – mean ion energy.

As a base for laboratory ion source Hall thruster model with diameter of 70 mm was used. Parallel to RF power supplied to ion source’s electrodes the anode was biased with constant voltage respectively to grounded hull. During experiments current-voltage characteristics of DC and RF channels were recorded, as well as ion beam energy distribution by the means of retarding field energy analyzer. Krypton with flows of 15–30 sccm was used as a working gas. Magnetic field on the exit of discharge chamber was radial with approximate value of 200 G. RF power varied in a range of 80–200 W. Constant voltage bias of loaded electrode varied from 0 to 400 V.

Results of the experiments have shown that ion beam density is proportional to RF power while its mean energy almost does not depend on RF power and changes with constant bias of loaded electrode. Such dependencies allow for independent control of ion beam density and energy even despite the fact that constant bias still influence ion beam current. The increase in ion energy was found to be less than respective value of constant bias multiplied by ion charge. This fact is explained by interaction of DC and RF discharge channels, in particular by change of discharge RF voltage amplitude with the value of constant bias under fixed discharge RF power.

References

1. V.P. Kim. Technical Physics, Vol. 85, I. 3, P. 45–59 (2015).
2. I.I. Zadiriev, A.A. Rukhadze, E.A. Kralkina, V.B. Pavlov, K.V. Vavilin, V.P. Tarakanov. Technical Physics, Vol. 86, I. 11, P. 1–5 (2016).
3. I.I. Zadiriev, A.A. Rukhadze, E.A. Kralkina, V.B. Pavlov, K.V. Vavilin. Applied Physics,   
   No. 4, P. 39–41 (2016).