MODEL OF A PLASMA LAYER FORMED BY AN ELECTRON BEAM [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.111

1,2Kolodko D.V., 1,2Sorokin I.A., 3,1Tarakanov V.P.

1Kotel’nikov Institute of Radio Engineering and Electronics (Fryazino Branch), Russian Academy of Sciences, Fryazino, Moscow oblast, 141120 Russia,  
2National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, 115409, Russia  
3Joint Institute of High Temperatures of RAS, Moscow, 125412, Russia

The scalability of basic elements in digital electronics is approaching to the limit determined by physical laws. It is necessary to introduce qualitatively new materials and electronic devices based on new physical principles for increasing processor performance and reduce the size of integrated circuits. Both nanometer devices based on traditional materials and especially new materials require defect-free and charge-free plasma technologies.

A beam-plasma discharge (BPD) in weak magnetic field has certain advantages in problem of obtaining and processing nanoscale films and structures [1]. Compared to RF and microwave discharges traditionally used in industrial installations, BPD enables precise control of energy of the incident ions in the 10 – 100 eV range. Low ion energies provide minimum density of radiation defects. It was shown earlier [2] that BPD as a plasma source can be successfully used both for soft-etching of semiconductor structures and for the synthesis of nanosized carbon films.

In a previous work [4], the formation of beam instability in a volume filled with previously created plasma with a density of 1010 cm-3 was simulated.

In this paper, we studied the development of beam instability created by an electron beam without pre-ionization and with zero longitudinal magnetic field. We confirm the weak influence of microwave oscillations on the peripheral plasma. In further it will allow us to divide the model into two parts: the region of beam instability for study of plasma formation, and peripheral plasma for studying problems of the interaction of plasma with walls and processed structures. Since the model has different orders of magnitude in density and time, it will significantly reduce the needed calculation time.

To simulate the development of beam instability and plasma formation, the KARAT software package was used [6, 7].

The work was carried out within the framework of the state task and partially was supported by the Russian Foundation for Basie Research, the projects No 18-38-00884, 19-07-00432.

References

1. N.V. Isaev, A.A. Rukhadze, E.G. Shustin // Plasma Phys. Reports. 2005. V. 31 (11). P. 953–960. doi: 10.1134/1.2131131.
2. E.G. Shustin // Journal of Communications Technology and Electronics. 2017. V. 62 (5). P. 454–465. doi: 10.1134/S106422691704012X.
3. V.P. Tarakanov Multipurpose electromagnetic code KARAT // Math. Model. Probl. Results. Moscow. Nauka, 2003.
4. V.P. Tarakanov, E.G. Shustin // Plasma Phys. Reports. 2007. V. 33 (2). P. 151. doi: 10.1134/S1063780X07020067.
5. I.A. Sorokin, E.G. Shustin // Plasma Phys. Reports. 2018. V. 44 (10). P. 849–854. doi: 10.1134/S1063780X18120061.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Lt/ru/EM-Kolodko.docx) [↑](#footnote-ref-1)