Plasma sheath and presheath in a collisionless plasma in the presence of a plasma source

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A model is constructed allowing computer simulation of the near-wall area of a flat plasma sheet in conditions where the steady state of the plasma is supported by its reproduction in the central part of the sheet. The model is essentially adequate to plasma layer generated in the plasma reactor with the beam excited plasma. It is shown that the higher mobility of electrons compared with ions ensures that the acceleration of ions from the region of reproduction into the presheath and, thus, the fulfillment of the Bohm criterion, necessary for the formation of the stationary plasma sheath. Calculations have revealed the effect of changes of energy distribution of electrons in time and on sheet thickness (cooling the electronic component) due to absorption of fast electrons at the walls limiting the plasma volume. . The plasma density profile across the sheet width has an abrupt decrease at the boundary of the source region. Thus, the calculations according to the model that most adequately describes the stationary state of a plasma with an extended source of charged particles, remote from the absorbing wall, reveal that the fundamental assumption of a stable and isotropic Maxwellian energy distribution for the electrons in the pre-sheath underlying theoretical concepts [1, 2] on the structure and properties of the edge layer is not implemented. This calls into question applicability of the standard concept of the sheath and pre-sheath [1, 2] in real conditions.

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References

1. Rieman К.-U. J. Phys. D: Appl. Phys. 1991; v24, p492
2. Lieberman M A, Lichtenberg A J. Principles of plasma discharges and materials processing. John Wiley & Sons, Inc., N.Y., USA, 1994; 572 pp