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Effect of the Oscillation of Upstream Plasma Density on Plasma Meniscus in RF Negative Ion Sources

Recently, it has been observed in RF H- sources that the beam optics, for example, the beam divergence angle oscillates periodically[1]. Therefore, it is important to understand the effect of time-oscillation on the plasma meniscus in the downstream extraction region close to the extraction hole under the existence of a large amount of negative ions.

As a first step for understanding meniscus oscillation, dependence of the meniscus shape on the upstream plasma-density has been investigated by using a 3D-PIC code, KEIO-BFX code. Taking the upstream plasma-density as a parameter, a series of simulations has been carried out for the range of 5×1017~1.5×1018 m-3. In each case, the simulation has been continued until the steady state has been obtained for a given value of the constant upstream plasma-density. The effect of both volume and surface produced H- ions are taken into account.

The comparison of the results among a series of simulations shows that the effective distance between the plasma meniscus and the extraction grid depends on the upstream density. Also, it has been shown that the meniscus depends on the amount of the surface negative ion production and the ratio of the negative ion and electron density even in the same upstream plasma-density [2.3].

In this study, as a next step, we investigate the time evolution of the plasma meniscus in the oscillating upstream plasma density assuming the RF discharge. For this purpose, KEIO-BFX is extended to time-dependent simulation model, the upstream plasma density oscillating by the time variation of the RF input power deposition. In the presentation, the time-evolution of the meniscus shape, the potential profile, the extracted beam quality, etc. will be discussed.

[1] T. Shibata, et al, AIP Conference Proceedings 2373, 050002 (2021)

[2] K. Hayashi, et al., Plasma Fus. Res. 18, 1401008 (2023).

[3] K. Hayashi, et al, in proc. Negative Ions, Beam and Sources, online, October 2022.

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