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Parasitic effects accompanying plasma-optical mass separation

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The technology of plasma-optical mass separation (POMS) implies, for a particular separator design, a certain maximum energy of ions in the multicomponent flux. The source of the ion beam in POMS is represented by the plasma accelerator (PA), the ion flux from which must pass through a device called the azimuthator, a magnetic barrier (MB). Within it, the ions of different masses gain corresponding azimuthal velocities (energies), in accordance with which each of them does focus on its respective receiver in the separating space of POMS representing the Hughes-Rozhansky energy analyzer. Publications report on the observation of the PA operation modes where a significant number (up to 80%) of ions are generated with energies exceeding the value determined by discharge voltage U_d (Fig. 1; the values averaged over 20 ms). For POMS this is inacceptable. This paper discusses the causes for the generation of anomalous ions, both in a macroscopic potential jump in anode layer and as a result of acceleration in the interaction with plasma oscillations. An important factor for any mass separator is its output. It has been found experimentally that ion losses in POMS occur, as was to be expected, when they pass through MB. For the non-monoenergetic ion flux, it is determined theoretically that there exists an optimum initial (at the MB input) density n0, at which the current at the MB output reaches a maximum value and the range of initial densities where the ion losses are relatively small (Fig. 2).

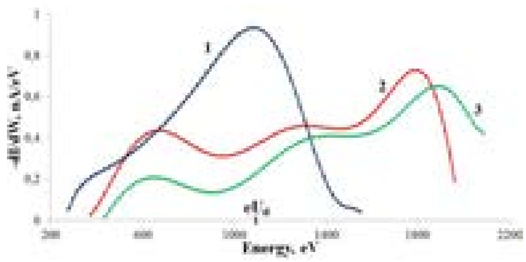

Figure 1: Evolution of the energy spectrum of ions with a change of the sort of gas: 1 – nitrogen, 2 – helium, 3 – argon; U_d = 1100 V; P = 12×10^{-5} Torr; B = 0.03 T.

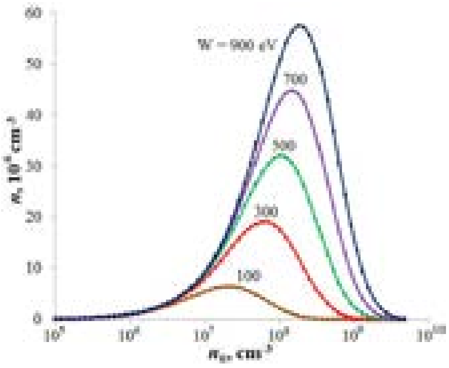

Figure 2: Flux density of ions that have passed through the magnetic barrier, as a function of initial density.

Recent Publications

1. Bardakov V, Ivanov S, Kazantsev A, Strokin N, Stupin A, et al. (2018) Anomalous acceleration of ions in a plasma accelerator with anodic layer. Plasma Science and Technology 20:035501.
2. Bardakov V, Ivanov S, Kazantsev A, Strokin N and Stupin A (2016) Super-acceleration of ions in a stationary plasma discharge. Physics Letters A 380:3497–3499.
3. Bardakov V, Ivanov S and Strokin N (2014) Advances and problems in plasma-optical mass-separation. Physics of Plasmas 21:033505.
4. Morozov A and Semashko N (2002) On the mass separation of quasineutral beams. Technical Physics Letters 28:1052–1053.

Biography

Nikolay Strokin currently works at the Irkutsk National Research Technical University. Nikolay does research in Plasma Physics. Their current project is 'Plasma-optical mass-separation'.

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