Gasdynamic ECR Sources of Multicharged Ions

S. Golubev A. Bokhanov I. Izotov S. Razin A. Sidorov
V. Skalyga A. Vodopyanov V. Zorin
(Institute of Applied Physics RAS, 46 Ulyanov St., Nizhny Novgorod, Russia)

Abstract A new type of pulse sources of multicharged ions, namely, a quasi-gasdynamic ECR source is propose. Its main difference from the classical ECR ion sources is a different, quasi-gasdynamic regime of plasma confinement in a magnetic trap. A zero-dimensional model was constructed that describes gas breakdown, formation of charge state distribution in a plasma, and plasma flux through the plugs of the trap. A wide spectrum of model experimental studies was covered. Plasma was produced and heated by a pulse (1ms) gyrotron at the frequency of 37.5GHz and power of 100kW in a cusp magnetic trap with magnetic field in plugs up to 2.5T. Such a trap has axisymmetric configuration and allows one to realize a quasi-gasdynamic regime of confinement with reliable stabilization of MHD perturbations. It was demonstrated that with such a confinement regime it is possible to generate multicharged ions and create intense (more than $1A/\mathrm{cm}^2$) ion fluxes through the trap plugs. Comparison of results of calculations and data of experiments shows that they are in a good agreement, which allows us to predict with a high degree of certainty creation of an ECR source of a new generation.

The data obtained were used to design a pulse quasi-gasdynamic ECR ion source with pumping at the frequency of 100GHz, effective trap size 1m, average ion charge in plasma comparable with that in the best classical MCI ECR sources but with an order of magnitude higher flux density and absolute magnitude of plasma flux through trap plugs. Creation of intense plasma fluxes allows one to extract high-current MCI beams of high brightness. Transverse homogeneity of a plasma flux makes it possible to use multi-aperture extraction system for formation on broad intense MCI beams.

Received 20 April 2007