High current gasdynamic electron cyclotron resonance ion sources with gyrotron plasma heating

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Fundamental research of a powerful millimeter wave gyrotron radiation interaction with an electron cyclotron resonance (ECR) discharge plasma confined in an open magnetic trap carried out at the Institute of Applied Physics of Russian Academy of Sciences (IAP RAS) have resulted in development of a new type of ECR ion sources – a gasdynamic ECR ion source. The key feature of the source is the high plasma density up to 10^{14} cm^{-3} combined with almost 100% ionization degree and electron mean energy in the range from tens to hundreds electronvolts. Such combination of the plasma parameters leads to a so-called quasi-gasdynamic confinement regime and allows production of very intense beams of protons either multicharged ions for different applications.

At SMIS 37 experimental facility equipped with 37,5 or 75 GHz / 100 kW gyrotrons in a pulsed operation a possibility of ion beams formation with current up to 500 mA, current density at the level of 600 – 700 mA/cm^2 in combination with low emittance (normalized RMS emittance below 0.1 $\pi \cdot mm \cdot mrad$) was demonstrated.

The next step in the research is a transition to continuous wave (CW) operation. For this purpose, preliminary studies of plasma parameters were performed using a CW source with 24 GHz/5 kW gyrotron heating. To continue development of the CW gasdynamic ion source a new experimental facility is under construction at the IAP RAS. Future source will utilize 28 and 37,5 GHz gyrotron radiation for plasma heating. Overview of the obtained results and the status of the new source development will be presented.

According to estimations, ion source output parameters would be enough for development on its basis of a D-D neutron generator with neutron flux density about 10^{10} – 10^{11} $s^{-1}cm^{-2}$. It is assumed that such neutron source could be perspective as a comparably compact device for boron neutron capture therapy studies.

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