Development of ECR Negative Ion Sources - Effects of Argon Addition for ECR Plasmas

K. Fujikja and O. Fukumasa

Yamaguchi University,
Tokiozawa 2-16-1, Ube 755-8611, Japan

Negative ion sources for neutral beam injection (NBI) systems are extensively studied for future large experimental fusion devices. In the present, the source plasma is generated by DC arc discharge where a hot filaments act as cathode. The lifetime of ion sources is limited to several hundred hours due to erosion and fatigue of the cathode filaments. Thus, extending the life of ion sources is required for future NBI systems. A microwave-discharge ion source and an RF-driven ion source are promising as long-lifetime ion sources because they have no filaments.

We have studied high-density plasma production and high efficiency $H^-$ production in ECR discharge plasmas with nine-cup and ring-cups-type magnetic fields, which are different ECR resonance conditions. According to our previous results [1][2], in the extraction region, electron temperature $T_e$ in ECR plasma is higher than that in DC plasmas. This result indicates that, in controlling plasma parameters, the effect of magnetic filter for ECR plasmas is weaker than that for DC plasmas. Also, electron density $n_e$ in the source region is much lower than one in DC plasmas. Thus, extracted $H^-$ current from ECR plasmas was small. According to these results, with adding Ar to H$_2$ discharges for enhancement of $n_e$, in this paper, we report the effects of Ar addition on plasma parameters and negative ion production in ECR plasmas.

ECR negative ion source chamber (210mm in diameter 300mm in length) made of stainless steel is a conventional multicusp volume source equipped with both magnetic filter and plasma grid. Plasma parameters were measured by using Langmuir probe movable in axial direction. Faraday cup with deflection magnet was used for measurement of extracted $H^-$ current. For several values of H$_2$ base pressure, Ar is added and its pressure is increased up to about 50% of the initial H$_2$ pressure.

By adding Ar, $n_e$ is increased more efficiently than $n_e$ in pure H$_2$ discharge case. At the same time, $T_e$ hardly changes. Although plasma condition ($n_e$, $T_e$) is changed to be suitable for $H^-$ production, $H^-$ current is decreased. By the way, there is a close relation between $H^-$ production and the vibrationally excited hydrogen molecules H$_2$($v^a$) [3]. From the viewpoint of producing H$_2$($v^a$), the influence of addition of Ar for $H^-$ production has been studied with VUV emission [4]. Then, details of effects of Ar addition for ECR Plasmas are now under study.

References:

fukumasa@plasma.see.yamaguchi-u.ac.jp