Plasma spectroscopy for ECR ion source tuning at RIKEN

H. Muto, 1 M. Kase, 1 K. Kobayashi, 1 M. Nishimura, 1 S. Kubono, 1 Y. Oshiro, 2 Y. Kotaka, 2 H. Yamaguchi, 2 T. Hattori, 3 and S. Shimoura 2

A grating monochromator with a photomultiplier was installed at the Hyper-ECR ion source, and the light intensities of gaseous and metal ion beams were observed during beam tuning. During beam tuning, the charge distribution of ions extracted from the ECR plasma has been measured using a magnetic beam analyzer and a Faraday cup. After beam extraction, the ion beam intensity was maximized in order to reach the highest possible efficiency. During this process, a coincidental appearance of the same Q/M species occurs in the ECR plasma and their separation by a magnetic beam analyzer is extremely difficult. Especially, in the case of 7Li3+ beam tuning, Helium is used as supporting gas to keep the plasma condition stable and it is almost impossible to separate 7Li3+, H2+, and He2+ (Q/M = 1/2) using a magnetic analyzer. Therefore, observing the light intensity of desired ion species from a photomultiplier combined with a monochromator was decided to tune the beam. The conceptual diagram of this work is presented in Fig. 1.

Fig. 1. Conceptual image of beam separation by an optical monochromator.

Figure 2 shows the light intensity of the 6Li III line spectrum (λ = 516.7 nm) as a function of the analyzed 7Li3+ beam intensity measured by the Faraday cup at the extraction section behind the beam deflector of the AVF cyclotron. The AVF cyclotron has a sufficient high resolution for this process (ΔM/M = 1/1200). The 6Li3+ beam intensity was tuned by controlling the RF power, the flow rate of the supporting gas, and the position of the micro oven in the ECR chamber. This result clearly shows a linear correlation of a light intensity and a beam intensity. Figure 3 shows the time charts of 7Li3+ beam current and Li III light intensity (λ = 449.8 nm) during beam tuning recorded by a pen recorder. As the 7Li3+ beam current increased, the light intensity of the Li III spectrum also increased. These results clearly show a linear correlation of these two values.

References