Plasma spectroscopy for ECR ion source tuning at RIKEN

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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.[1~3] 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 $^{6}Li^{3+}$ beam tuning, Helium is used as supporting gas to keep the plasma condition stable and it is almost impossible to separate $^{6}Li^{3+}$, H_2^{+}, and He^{2+} (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.[4] The conceptual diagram of this work is presented in Fig.1.

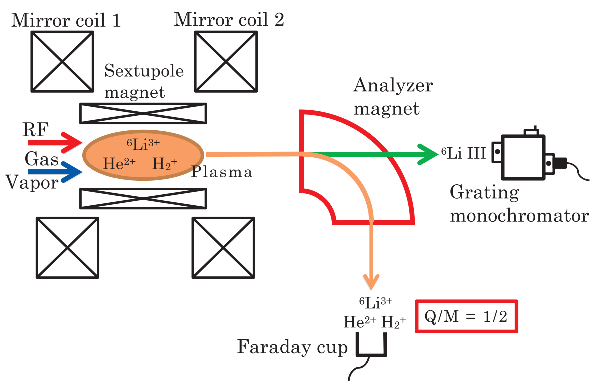

Fig. 1. Conceptual image of beam separation by an optical monochromator.

Figure 2 shows the light intensity of the ^{6}Li III line spectrum (λ = 516.7 nm) as a function of the analyzed $^{6}Li^{3+}$ beam intensity measured by the Faraday cup at the extraction section behind the beam deflector of the AVF cyclotron.[4] The AVF cyclotron has a sufficient high resolution for this process ($\Delta M/M$ = 1/1200). The $^{6}Li^{3+}$ 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 $^{7}Li^{3+}$ beam current and ^{7}Li III light intensity (λ = 449.8 nm) during beam tuning recorded by a pen recorder.[4] As the $^{7}Li^{3+}$ beam current increased, the light intensity of the ^{7}Li III spectrum also increased. These results clearly show a linear correlation of these two values.

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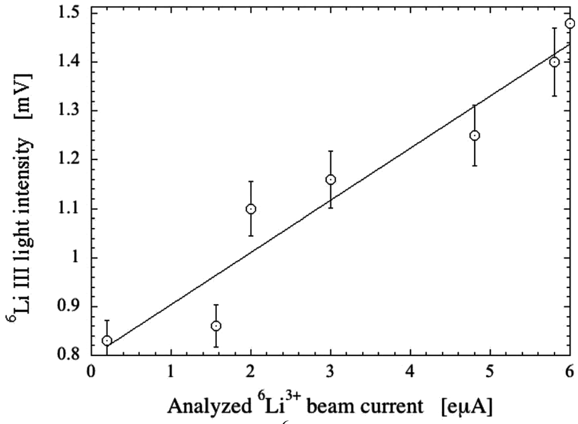

Fig. 2. Light intensity of ^{6}Li III line spectrum as a function of analyzed $^{6}Li^{3+}$ beam intensity measured by a Faraday cup positioned at the extraction section after beam deflector of the cyclotron.[4]

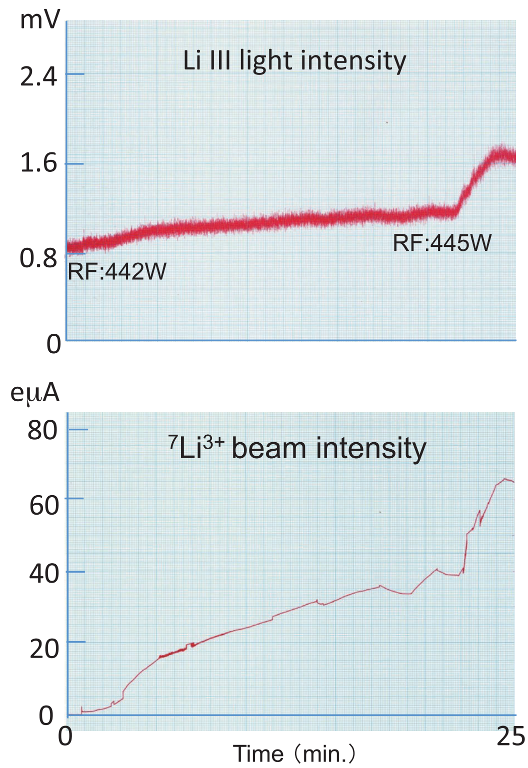

Fig. 3. Time charts of $^{7}Li^{3+}$ beam intensity and ^{7}Li III light intensity during beam tuning.

References

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4) H.Muto et al., Rev. Sci. Instrum. **85**, 126107 (2014).