Present operation status of ERIS at the SCRIT electron scattering facility

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The electron-beam-driven radioactive isotope separator for SCRIT (ERIS)[1] at the SCRIT electron scattering facility[2] is an online isotope-separator system used to produce low-energy radioactive isotope (RI) beams using the photofission of uranium. Last year, we successfully performed the world's first electron scattering experiment with online-produced RI.[3] Further, we also started the systematic study of nuclear structure using electron scattering using Xe isotopes. Following last year, we continued the experiment using Xe isotopes, particularly ^{124,126,128}Xe isotopes. In this paper, we report the ion beam supply of Xe isotopes.

The ion beams of Xe isotopes have been supplied using the FEBIAD type ion source. Details of the FEBIAD type ion source at ERIS are reported in Ref. 4). The ion beam energy was 6.18 keV, determined by the high voltage stage of 6 kV and the anode voltage of the ionization chamber of 180 V. Natural Xe gas was injected directly into the ionization chamber. To supply ion beams of isotopes with low natural abundance ratio, the gas supply was carefully controlled by monitoring the pressure of the ion source to prevent discharge inside the ion source.

Figure 1 shows the mass spectra of Xe isotopes for different gas supply quantity. The black and red lines represent results obtained at the pressures of 3.4×10^{-5} and 3.4×10^{-4} Pa for the ion source, respectively. The total beam current was measured at the downstream of the ion source using a Faraday cup before conducting mass analysis. The total beam currents for the black and red spectra were 1.2 and 4 μA, respectively. The change in the total beam current was not proportional to the change in the pressure, because the pressure of the ionization chamber was not directly measured and the extraction efficiency was considered to be reduced owing to the space charge inside the ionization chamber. The results in Fig. 1 show the shift in peak positions and a larger tail on the lower side of the peak. In the case of the red spectrum, the peaks of the ions with low natural abundance ratio that are ^{124,126,128}Xe isotopes, were covered by the tail from the peaks of the ions with high natural abundance ratio and could no longer be separated. A qualitative explanation of this phenomenon can be understood as the positive charge owing to the large number of Xe ions increasing the potential inside the ionization chamber and widening the potential difference with the outlet. The difference in peak position was equivalent to approximately 50 V when converted to the ion beam energy. Compared to the anode voltage of 180 V, this value caused a considerably large effect. Currently, detailed potential calculations in the ion source are underway.

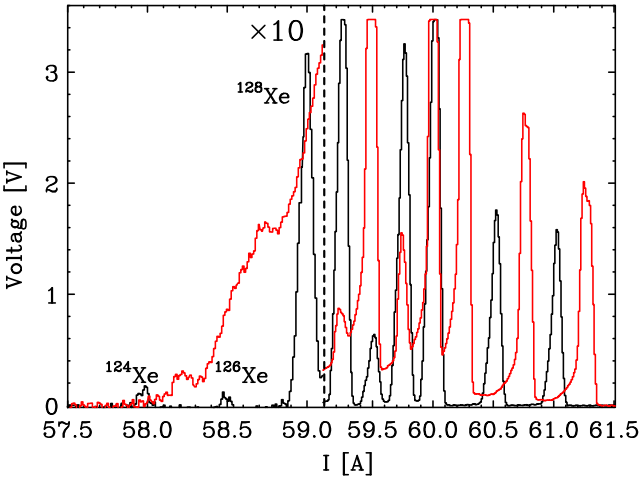

Fig. 1. Mass spectrum of Xe isotopes plotted with the current value of the analyzing magnet. The black and red lines represent the results obtained for different gas supply quantity at the pressures of 3.4×10^{-5} and 3.4×10^{-4} Pa for the ion source, respectively. In the area to the left of the dotted line, the voltage shown is the original voltage multiplied by 10.

During the experiment, the ion beams of Xe isotopes with low natural abundance ratio were supplied under conditions that facilitated proper separation while checking the mass spectrum, and the beam current of ^{124}Xe ions was approximately 0.5 nA.

In next fiscal year, further Xe experiments will be conducted. In addition, we will proceed with the development of ERIS concerning ionization and extraction methods for high-efficiency ion sources and radiation shielding to accommodate the accelerator upgrade.

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