Spectroscopic analysis of radioactive Sr isotope with high isotopic selectivity. (2) Multi-step RIS of ^{90}Sr with IF-ECDL and characteristics evaluation.

*Donguk Cheon[1], Yoshihiro Iwata[1], Masabumi Miyabe[2] and Shuichi Hasegawa[1]
[1]University of Tokyo, NEM Dep., [2]JAEA

Abstract:

On this series of report, firstly, we present the development of Resonance ionization spectroscopic (RIS) system with interference filtered external cavity diode laser (IF-ECDL; 689 nm). Secondly, characteristics of IF-ECDL and grating controlled ECDL (G-ECDL; 487 nm) system. And then finally, the results of multi-step RIS (689.4 nm – 487.4 nm; $5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s4d^3D_2$.) of Sr are reported.

Keywords: Interference filter, ECDL, Strontium, Resonance ionization

1. Introduction

Developing radioactive isotope tracing technology is a focal topic after the Fukushima Daiichi nuclear power plant accident such as strontium 90. Tracing and monitoring ^{90}Sr is not easy due to its low isotopic abundance, and isobaric interference by equal mass isotopes of other elements. To present higher isotopic selectivity of the strontium, multi-step resonance ionization at 689.4 nm ($5s^2\ ^1S_0 – 5s5p^3P_1^0$, Γ= ~7.5 kHz) [1], it is required to develop narrow band output laser system. We developed 689.4 nm output ECDL laser system whose mode selection is performed by interference filter instead of conventionally applied grating. Based on cat's eye retroreflector, it is expected to present kHz level linewidth [2]. In this study, we presented resonance ionization of strontium at 689.4 nm – 487.4 nm ($5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s4d^3D_2$) with the IF-ECDL system.

2. Experimental

To perform the multi-step resonance ionization at 689.4 nm – 487 nm ($5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s4d^3D_2$), we built the narrow band laser system with IF-ECDL. Commercial laser diode (Thorlabs, HL6750MG 685 nm) was applied to the IF-ECDL system with collimation lens tube. Partial mirror was set as the retroreflector of the system. Angle controlled band pass filter was installed between collimated laser diode and partial mirror as the wavelength selector. On the other hand, based on a Haensch type structure of ECDL, the laser system for second excitation of strontium (487 nm) was built with a G-ECDL system. Grating roles as a retroreflector and wavelength selector, simultaneously. Figure 1 presents the RIS system with IF-ECDL system. The ion signal at 689.4 nm – 487 nm ($5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s4d^3D_2$) revealed ~$10^{-3}$ of signal at 460 nm – 405 nm ($5s^2\ ^1S_0 – 5s5p^1P_1^0 – 5p^2(^1D_2) + 4d^2(^1D_2)$) due to low Γ of transition at 689.4 nm as figure 2.

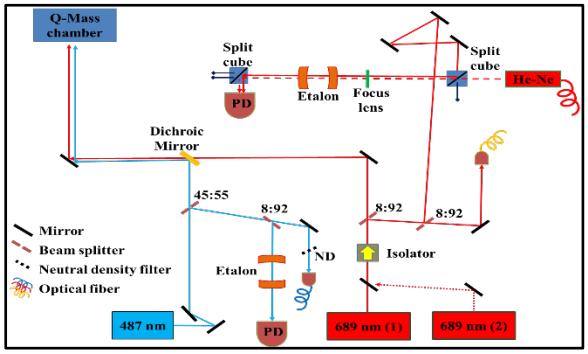

Figure 1. Scheme of the RIS system with IF-ECDL system (689.4 nm).

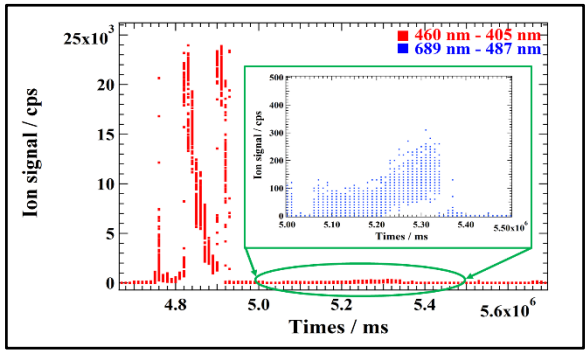

Figure 2. Ion signal. Red dots are the transition of 460 nm – 405 nm. And Blue dots are the transition of 689.4 nm – 487.4 nm – 487.4 nm

3. Conclusion

IF-ECDL system (689 nm) for enhancing the isotopic selectivity of Sr has been developed. Characteristics of the two systems, IF-ECDL (689 nm) and G-ECDL (487 nm), have been analyzed. Resonance ionization of strontium at 689.4 nm – 487.4 nm ($5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s4d^3D_2$) has been performed. Three step resonance ionization (689.4 nm – 688 nm – 487.6 nm; $5s^2\ ^1S_0 – 5s5p^3P_1^0 – 5s6s^3S_1 – 4d6p^3P_1^0$) will be performed with building tapered amplifier (TPA) system, to enhance the beam power at 689.4 nm.

References

[1] B.A. Bushaw et. Al., Spectrochim. Acta, Part B, 52, 1839, 1997.
[2] A. Takamizawa et. Al., App. Phys. Exp., 9, 032704, 2016.