2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Atomization and Number Density Measurement of Strontium in Arc-jet

Yasuaki Aiba[1], Akira Kuwahara[2, 1] and Makoto Matsui[1]
[1] Department of Engineering, Shizuoka University, [2] Japan Atomic Energy Agency
e-mail:i_ba5761455@yahoo.co.jp

1. Introduction

In the atomic energy field, isotope analysis of radioactive nuclides is necessary for the safe disposal of radioactive wastes and debris. In case of isotope analysis, mass spectrometry is the conventional method, though chemical separation procedure of samples requires a long time. (1) Additionally, there is a possibility of interfering by isobars in mass spectra. Therefore, spectroscopy methods are attracting attention as novel isotope analysis method. For instance, laser ablation techniques combined with laser absorption spectroscopy has high wavelength selectivity. However, the atomic spectrum of laser ablation plasma is so broad that we cannot distinguish each isotope shift of the spectrum because the typical temperature of laser ablation plasma is approximately 8,000 K. (2)

We have developed a direct analytical method using laser absorption spectroscopy and arc plasma wind tunnel. The concept of the system is shown in Fig.1. The driving gas goes through both high-temperature section and low-temperature section. The powder samples are thermally decomposed and atomized in high-temperature section and led to vacuum chamber via the divergent nozzle. At the same time, the plasma becomes low temperature by the effect of adiabatic expansion. The broadening of the spectrum is narrow when the temperature of the plasma is low, so isotope shift of the spectrum is available in supersonic plasma flow in are plasma wind tunnel.

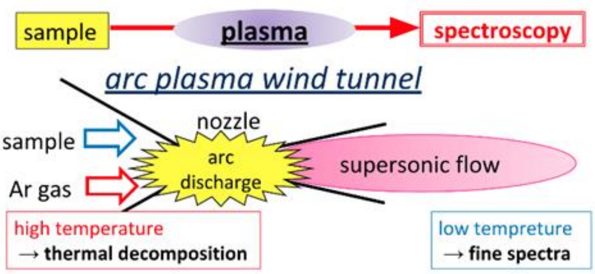

Figure 1 The concept of the system.

In the past study, strontium chloride ($SrCl_2$) powder is used as a demonstration sample and fed into argon arc-jet. The atomization of the sample is confirmed by emission spectroscopy (Fig.2). For the next step, laser absorption spectroscopy is going to be adopted to arc-jet and the temperature and number density of atomic strontium is subject to be evaluated. Strontium has two resonance lines, Sr I 689 nm ($A=4.7\times10^4$) and Sr I 460 nm ($A=2.0\times10^8$). The sufficient number density of strontium in arc-jet and the stability of sample atomization are required.

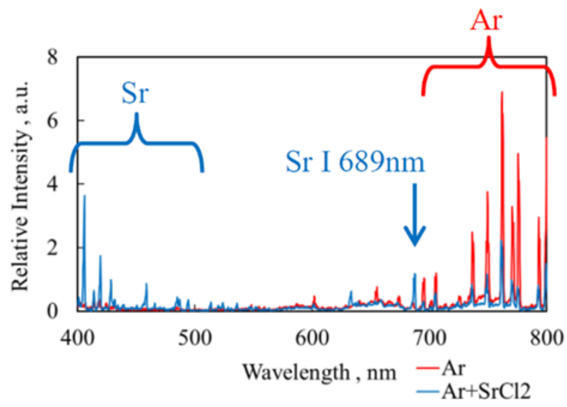

Figure 2 Emission spectra of the arc-jet with/without SrCl2 powder.

2. Theorem and Experimental Setup

The relationship between incident and transmitted laser intensities are described by Beer-Lambert equation (1).

$$\frac{I_t}{I_0} = \exp(-\alpha L) \qquad (1)$$

Number density is related to integrated absorption coefficient K.

$$n_i = \frac{8\pi}{A_{ij}\lambda^2}\frac{g_i}{g_j}K \qquad (2)$$

The setup for laser absorption spectroscopy is shown in Fig.3.

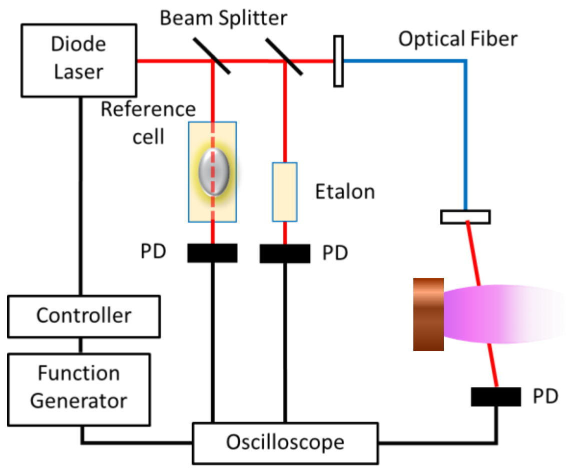

Figure 3 LAS setup.

References
(1) M. Miyabe, M. Oba, H. Iimura, K. Akaoka, Y. Maruyama and I. Wakaida, Appl. Phys. A: Mater. Sci. Process., 2010, 101, 65.
(2) H. Liu, A. Quentmeier and K. Niemax, Spectrochim. Acta, Part B, 2002, 57, 1611.