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Lithium isotopes abundance analysis in liquid phase by laser-produced vapor for laser-induced breakdown spectroscopy

Duksun Han[1], Tuyen Ngoc Tran[1], Sungyong Shim[1]

[1]Institute of Plasma Technology, Korea Institute of Fusion Energy
e-mail (speaker): dshan@kfe.re.kr

Lithium (Li) isotopes play important roles in nuclear fusion processes. There are two isotopes of lithium in nature with the abundances of 7.53% for ^{6}Li and 92.47% for ^{7}Li. However, ^{6}Li was found that it had high cross-section than ^{7}Li for tritium production in the nuclear fusion power plant. Most of the Li isotopes enrichment methods were developed in liquid phase and the analyzing Li isotopes in liquid is essential.

In our experiment, lithium isotope abundances were measured by our developed laser-produced vapor for laser-induced breakdown spectroscopy (LPV-LIBS) method [1]. The LPV-LIBS was configured using a two-beams 10 Hz nanosecond Nd:YAG pulse laser with the maximum energy of 150 mJ/pulse. The first beam at the wavelength of 532 nm was used to vaporizing the Li in the liquid and the second beam at the wavelength of 1064 nm was used to generating the laser-induced plasma of the produced Li vapor. Different powder of Li compounds such as LiCl, Li_2CO_3 and LiOH were used to prepared liquid Li samples with different ^{6}Li/^{7}Li ratio. The concentration of the Li compound in aqueous solution was 5 mg/mL. Li spectra of the 2s-2p transition line at 670.8 nm from the laser-induced Li plasma were measured and analyzed by a high-resolution spectrometer. The correlation between the Li isotopes abundances in the liquid and the spectral shifts of the Li 2s-2p transition line was discussed.

Figure 1 illustrates the ^{6}Li abundance-dependent central wavelengths of as LiCl, Li_2CO_3 and LiOH. The wavelength shift between ^{6}Li and ^{7}Li was 15.5 pm, 16.1 pm and 16.8 pm for as LiCl, Li_2CO_3 and LiOH, respectively, closing to the theoretical expected value of 15.8 ± 0.3 pm. The error for Li isotope analysis by the LPV-LIBS was determined to be 2.5 to 5.2 %. The success of liquid Li isotope analysis by the LPV-LIBS can be applied for further development of the nuclear industry.

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References

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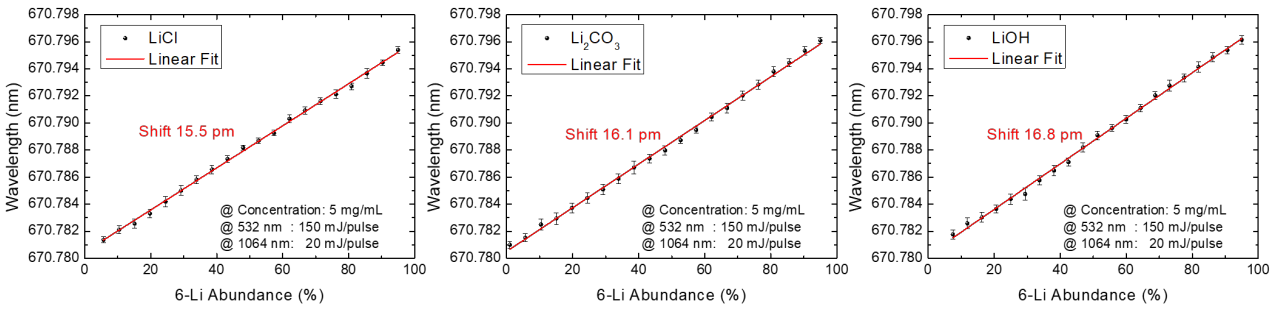

Figure 1. The ^{6}Li abundance-dependent central wavelengths of as LiCl, Li_2CO_3 and LiOH. The wavelength shift between ^{6}Li and ^{7}Li was 15.5 pm, 16.1 pm and 16.8 pm for as LiCl, Li_2CO_3 and LiOH, respectively, closing to the theoretical expected value of 15.8 ± 0.3 pm.