4 - 2 A Femtosecond Laser System used for Atomic Physics Research

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A Ti:sapphire femtosecond laser system for atomic physics research has been installed at IMP. The laser system was developed by the Institute of Physics of CAS. It consists a femtosecond Ti:sapphire oscillator seed, a pulse stretcher, a regenerative amplifier and a pulse compressor. The regenerative amplifier was pumped by a Nd:YAG laser with the 10 Hz repetiation frequency. The centre wavelength of this fs laser is 780 nm and the pulse width is about 60 fs (FWHM). The maxium pulse energy is 7 mJ.

A test experiment combining the fs laser system and the COTRIMS experimental setup has been performed. This laser system can run stably for several hours for experimental measuring. The laser beam with 500 μJ pulse energy was fouced on argon target by a lens with 300 mm foucal length. Fig. 1 shows the time-of-flight spectrum, and Ar^+, Ar_2^+ and Ar_2^+ were observed. A two-dimension momentum distribution of Ar_2^+ along the laser polarization was shown in Fig. 2.

In the future, the femtosecond laser system will also be used for Laser-induced breakdown spectroscopy research.

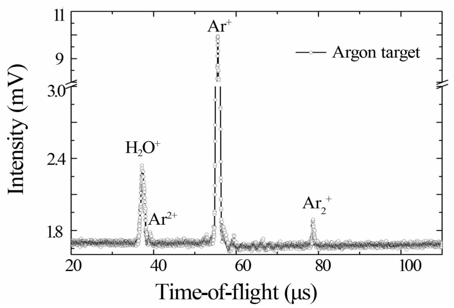

Fig. 1 Time-of-flight spectrum of argon ionized by femtosecond laser.

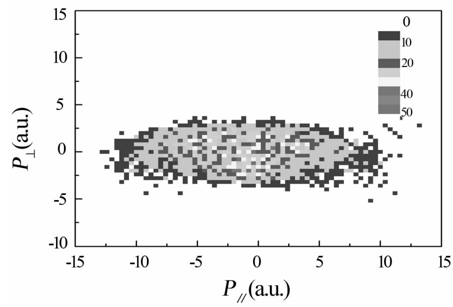

Fig. 2 Ion momentum distribution of Ar^{2+} along the laser polarization.

4 - 3 Rapid Detection of Chromium in Capsule by LIBS Analysis Technique

Zhang Dacheng, Ma Xinwen, Zhao Dongmei and Zhang Ying

Chromium-contaminated capsules events produced a tremendous impact on society in China 2012. However, the traditional methord such as graphite furnace atomic absorption spectrometry must spend long period to detect the Cr element in capsules and is not suitable for rapied detection.

In this work, we want to establish a methord for rapid detection of elements, especially for chromium, in capsules by laser-induced breakdown spectroscopy (LIBS) analysis technique. A double-pulse LIBS system was used here. One laser beam was used for ablation capsules to produce plasma and another laser was used to enhance the plasma spectrum with a several hundreds nanoseconds delay. The elements in capsules can be identified rapidly by analyzing the plasma spectra using a spectrometer. Morever, there was no special need to prepare the capsule samples and the analysis could be finished in serveral seconds. Fig. 1 shows the picture of the capsules after laser ablation. It can be found that the capsule nearly lossless. Our experimental results also show that Cr I (357. 34 nm) line is a good choice for chromium element analysis. In our experiments, 19 kinds capsule were analyzed and Cr lines were found in 11 samples. The spectra of three capsule samples in the range of 356～428 nm were shown in Fig. 2. Thereinto, chromium content in F sample was 7 ppm calibrated by atomic absorption methord. It can be decuced that the limit of detection

(LOD) of our LIBS system for Cr element in capsule is lower than 1 ppm. LIBS analysis technology is well suited for determining chromium content in capsules.

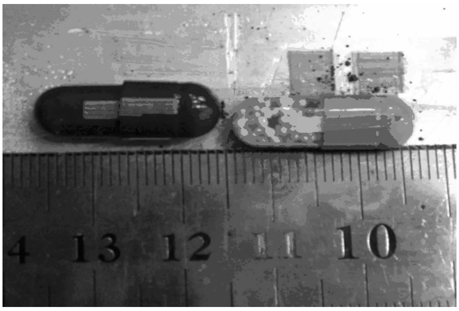

Fig. 1 The capsule after laser ablated.

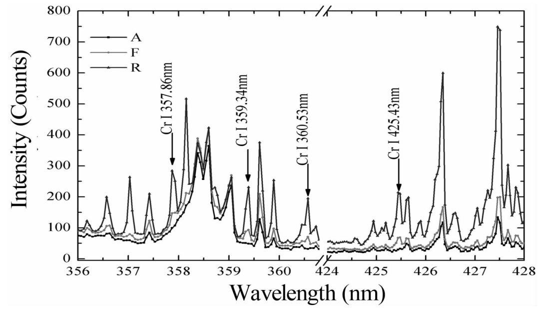

Fig. 2 The lines of Cr I.

4 - 4 Double-pulse Laser-induced Breakdown Spectroscopy in Aluminium Sample

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In the recent years, a great interest in double-pulse LIBS (DP-LIBS) has been raised as a consequence of its better performance, in terms of signal enhancement, as compared to single-pulse LIBS (SP-LIBS)[1]. In our experiments, a series of DP-LIBS experiments on allunium samples were performed with collinear DP-LIBS, orthorgonal reheating DP-LIBS and orthorgonal preablation DP-LIBS.

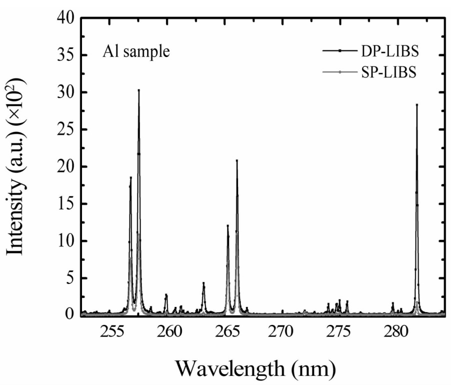

Fig. 1 Comparasion DP-LIBS result with SP-LIBS result.

The optimum delay time between laser and spectrometer was found to be 400 ns to obtain good SNR from single-pulse LIBS results. The parameters such as the delay time between laser pulses and laser wavelength combination were investigated to found maximal enhancement factor of DP-LIBS. Comparing with SP-LIBS using the first ablation laser beam, 11～73 fold enhancement was observed using 1064 nm 266 nm sequence colliear DP-LIBS and 2.5～11 fold enhancement was observed using 266 nm 1064 nm sequence orthorgonal reheating DP-LIBS. Fig. 1 shows a DP-LIBS result using 532 nm laser with 15 mJ pulse energy and 355 nm laser with pulse energy 50 mJ with orthorgonal reheating configuration. The time delay between laser pulses was 60 ns. 19 times intensity enhancement of Al II(281.6 nm) line was observed. With the help of emission imagies of plasma, the main enhancement mechanism of our experimental results was explained qualitatively.

Reference

[1] A. De Giacomo, M. Dell'Aglio, D. Bruno, et al., Spectrochimica Acta, B63(2008)805.