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Femtosecond double-pulse laser induced Cu plasma spectroscopy

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Synopsis The spectroscopy of plasma, formed by femtosecond double-pulse laser induced Cu at atmospheric pressure is investigated. The results show that the delay times between the pulses will affect the intensity of spectroscopy. In the range of 1 - 100 ps, the intensity increased with the delay between the pulses.

Recent developments in laser-induced breakdown spectroscopy (LIBS) have seen the introduction of double-pulsed laser systems. In the configuration the laser is fired twice on the same spot on the specimen with a pulse separation [1]. Depending on the pulse separation, the evolution of plasma is different from LIBS of the single pulse [2]. In this study, the emission intensity is investigated with the delay time of double-pulse on the plasma from Cu surface under the femtosecond double-pulse laser.

The laser system is a regenerative amplified Ti:Sapphire laser (Spectra Physics Tsunami oscillator and Spitfire amplifier). The full-width at the half maximum (FWHM) is 120 fs, the wavelength is 800 nm, the repetition rate is 1kHz. The individual pulse is splited into two sub-pulses by a beam splitter. The delay time may be changed from 1 to 110 ps. By a combination of a Glan laser polarizer and a half-wave plate, the energy of each sub-pulse can be attenuated to the desired value. The subpulses are directed by a beam splitter into a microscope objective (10, NA=0.25). The metal target is mounted on a computer-controlled X-Y-Z stage. All experiments are performed in air at atmospheric pressure. The each spectroscopy is an average of typically 200 shots. The plasma spectroscopy perpendicular to the laser beam is collected by lens, focused into a fiber, and detected with spectrometer (Avantes, AvaSpec-FAST).

The experimental results are shown in figure 1. The laser fluence is 43 J/cm^2. Fig. 1 displays the spectral intensity obtained from a Cu sample with femtosecond double-pulse laser. The delay time of double-pulse is 3, 6, 12, 25, 50, and 100 ps, respectively. The emission intensity increased with the delay time between the pulses, and became slow.

This result mainly based on three classes of mechanisms [3]: it is possible that the spectral intensity increases because more material is ablated from the surface by a double pulse as the result of a surface transformation induced by the first pulse; the enhancement may be caused by reheating of the plasma generated by the first pulse; hydrodynamic effects induced by the first pulse may affect the propagation of the laser beam and the expansion of the plasma generated by the second pulse.

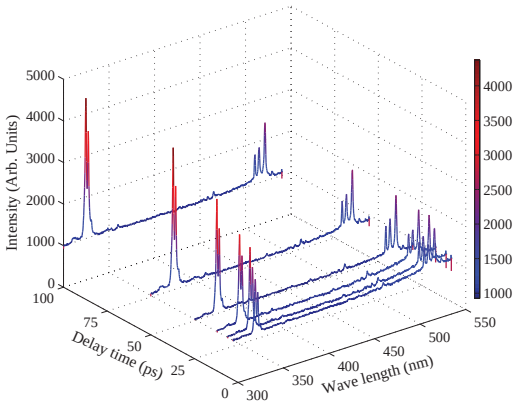

Figure 1. The spectral intensity with delay time, the whole fluence of double-pulse laser is 43 J/cm^2.

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References

[1] A. Semerok *at al* 2004 *Thin Solid Films* **453** 501

[2] Z. Hu *at al* 2007 *Appl. Phys. Lett.* **90** 131910

[3] S. Singha *at al* 2008 *J. Appl. Phys.* **104** 113520

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