Study of nanosecond resolved spectra and comparison between single and double pulse in linear configuration of aluminum plasmas

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Laser induced plasma spectroscopy is a very interesting technique that can be employed to characterize metallic materials by generating plasma due to the laser interaction to the samples. Some improvements of the technique are needed in order to obtain full correspondence between the sample characteristics and plasma generated during the ablation. Comparison between single and double-pulse (collinear configuration) was made in this work for laser induced plasma spectroscopy of high purity aluminum samples using a laser system with wavelength of 800 nm, 480 μJ of energy pulse (measured near the laser output), 1 kHz of repetition rate and 50fs FWMH. The emission from the plasma was collected by a lens and dispersed on a monochromator whose exit slit was connected to a photomultiplier. The spectra were recorded by the lock-in technique (time integrated spectra) as well as the box-car technique (time resolved spectra). Temperature and density were acquired using Boltzmann Plot and Stark broadening treatment, respectively. The collinear configuration with first pulse (374μJ) more energetic than second (106μJ) presents a temperature and density (49000 $\pm$ 36000 K and 1.36 $\pm$ 0.09 10^{17}cm^{-3} respectively) greater than single pulse (370μJ measured after passing the optical path through mirrors and focusing lens) and double-pulse with first pulse (42μJ) less energetic than second (308μJ) that has 11400 $\pm$ 900 K and 8.7 $\pm$ 0.5 10^{16} cm^{-3} and 8100 $\pm$ 200 K and 6.6 $\pm$ 0.3 10^{16} cm^{-3}. This behavior was attributed to the pre-ablative effect when the first pulse is more energetic than second. The study of emission lifetime of Al I 394.4 nm line and resolved spectra of plasma temporal evolution with delay times from 60 ns to 200 ns were used to chose the best delay to acquire the plasma information, the best delay acquired was 120 ns delay time due the maximum emission and spectra resolution.