Spectral characterization and temporal evolution of the induced plasma emission in the ablation of aluminium alloy

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Laser-induced breakdown spectroscopy (LIBS) is a powerful optical emission analytical tool capable of sampling solids, liquids and gases for research and industrial applications[1]. A pulsed high-power laser is used to ablate a piece of the sample and excite it till plasma state. The optical emission from the relaxation of excited species within the plasma yields information regarding the composition of the material under test. Moreover, LIBS enables the study of some parameters regarding the fundamental point of view: electron temperature Te and number density Ne. This is feasible since some assumptions can be made, such as the existence of local thermodynamic equilibrium (LTE) conditions and optically thin plasma. Even though the plasma parameters rapidly change during the measurement time due to its expansion, the plasmas fulfill LTE conditions.

In this communication we report some results on wavelength and time resolved measurements of the optical emissions in a plasma induced by both, Nd-Yag and CO₂ pulsed-laser on the target surface of an aluminium 2024 alloy. The composition of this alloy allows the analysis of emission lines from atomic and ionic species of Al, Mg, Cu and Mn. This study was made in both medium vacuum conditions and atmospheric pressure of air. In these conditions, vibrational bands sequence of AlO is observed. The time dependence and velocity distributions of space-integrated emission of some excited species are registered thanks to time-resolved optical emission spectroscopy and imaging techniques. Intensities of some species were used for determining electron temperature and their Stark-broadened profiles were employed to calculate electron density as described in previous papers[2-3]. Some important differences in the obtained spectra are observed because of different characteristics between Nd-Yag and CO₂ pulsed laser. The plasma spectrum obtained using CO₂ laser shows more lines, due to ionic species, than the plasma spectrum obtained using Nd-Yag laser. On the other hand, the imaging and time-resolved combined techniques allow the identification of some low-intensity lines, which are hidden in the integrated spectrum.

References