Time and space resolved optical emission diagnostics of laser induced breakdown muscle tissue samples

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The recent progress made in developing laser-induced breakdown spectroscopy (LIBS) has transformed this technique from an elemental analysis method to one that can be applied for the analysis of complex biological material or clinical specimens. The LIBS method has gained a reputation as a flexible and convenient technique for rapidly identification of unknown materials (chemical, biological or explosive). The plasma generated by LIBS technique on muscle tissue samples [1] was investigated using two high-power pulsed lasers (transverse excitation atmospheric CO_2 and Nd:YAG lasers). A remarkable fact is the no influence of the laser wavelength on the observed spectral lines and molecular bands. The emission of the plasma shows excited neutral Na, K, C, Mg, H, N and O atoms, ionized C^+, C^{2+}, Mg^+, N^+ and O^+ species and molecular band systems of $CN(B^2\Sigma^+ - X^2\Sigma^+)$, $C_2(d^3\Pi_g - a^3\Pi_u)$, $CH(A^2\Delta - X^2\Pi)$, $NH(A^3\Pi - X^3\Sigma^-)$ and $OH(A^2\Delta - X^2\Pi)$. For the assignment of the atomic/ionic lines we used the information tabulated in NIST [2]. The molecular bands were compared with the LIBS experiments obtained in our laboratory on different samples [3-6]. We focus our attention on the dynamics of the muscle tissue laser induced plasma species expanding into air (atmospheric pressure) or into vacuum (air pressures of 0.8 and 0.01 Pa). In conventional one dimensional optical emission spectroscopy (OES) studies, various plasma-plume segments were selected along the plume expansion axis and averaged over line-of-sight. This setup was easily transformed to a two-dimensional (2D) OES setup [7] by inserting a Dove prism between the focusing and collimating lenses. Time-integrated and time-resolved 2D OES plasma profiles were recorded as a function of emitted wavelength and distance from the target. Different plasma parameters such as velocities, temperatures and electron densities were evaluated using OES. The temporal behaviour of specific lines of atomic/ionic lines was characterized.

Acknowledgements

This work was partially supported by the MICINN (Spain, Ministerio de Ciencia e Innovación), project CTQ2010-15680, Autónoma University of Madrid, project CEMU-2012-003 and Complutense University of Madrid, grant CCG10-UCM/PPQ-4713.

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