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Calibration free laser-induced breakdown spectroscopy (LIBS) identification of seawater salinity

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Keywords

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Abstract

Laser-induced breakdown spectroscopy (LIBS) has been used as a remote sensing system to analyze seawater samples and to identify their salinities without ordinary calibration curves. The plasma is generated by focusing a pulsed Nd : YAG laser on the seawater surface in air at atmospheric pressure. Such plasma emission spectrum was collected using wide band fused-silica optical fiber of one-meter length connected to a portable Echelle spectrometer (Mechelle 7500 – Multichannel Instruments, Stockholm, Sweden) with intensified CCD camera. Spectroscopic analysis of plasma evolution of laser produced plasmas has been characterized in terms of their spectra, electron density and electron temperature assuming the local thermodynamic equilibrium (LTE) and optically thin plasma conditions. Three elements Na, Ca and Mg were determined in the obtained spectra to identify the salinity of seawater samples. The electron temperature T_e and density N_e were determined using the emission intensity and Stark broadening. The obtained values of T_e and N_e for natural seawater sample (salinity 3.753%) are 11580 K ± 0.35% and 3.33×10^{18} cm^{-3} ± 14.3%. These values exhibit a significant change only if the matrix changes (*i.e.*, the salinity changes). On the other hand, no significant difference was obtained if T_e and N_e were determined using any of the three elements (Na, Ca and Mg) in the same matrix. It is concluded that T_e and N_e represent a fingerprint plasma characterization for a given seawater sample and its salinity could be identified using only one element without need to analyze the rest of elements in the seawater matrix. The obtained results indicate that it is possible to improve the exploitation of LIBS in the remote on-line environmental monitoring, by following up only a single element as a marker to identify the seawater matrix composition and salinity without need to analyze that matrix which saves a lot of time and efforts.