OC-OT-LIBS: A novel approach to the chemical characterization of single particles

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Spectral identification of individual micro- and nano-sized particles by the sequential intervention of optical catapulting, optical trapping and laser-induced breakdown spectroscopy is presented[1]. The three techniques are used for different purposes. Optical catapulting (OC) serves to put the particulate material under inspection in aerosol form[2-4]. Optical trapping (OT) permits the isolation and manipulation of individual particles from the aerosol, which are subsequently analyzed by laser-induced breakdown spectroscopy (LIBS). Once catapulted, the dynamics of particle trapping depends on the laser beam characteristics (power and intensity gradient) and on the particle properties (size, mass and shape). Particles are stably trapped in air at atmospheric pressure and can be conveniently manipulated for a precise positioning for LIBS analysis. The spectra acquired from the individually trapped particles permit a straightforward identification of the inspected material.
The current work focuses on the development of a procedure for simultaneously acquiring dual information about the particle under study via LIBS and time-resolved plasma images by taking advantage of the aforementioned features of the OC-OT-LIBS instrument to align the multiple lines in a simple yet highly accurate way. The plasma imaging does not only further reinforce the spectral data, but also allows a better comprehension of the chemical and physical processes involved during laser-particle interaction. Also, a thorough determination of the optimal excitation conditions generating the most information out of each laser event was run along the determination of parameters such as the width of the optical trap, its stability as a function of the laser power and the laser wavelength. The extreme sensibility of the presented OC-OT-LIBS technology allows a detection power of attograms for single/individual particle analysis.

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