Heavy metals trace detection in water by LIBS using droplet levitation & CW laser drying – comparison with and without NP enhancement

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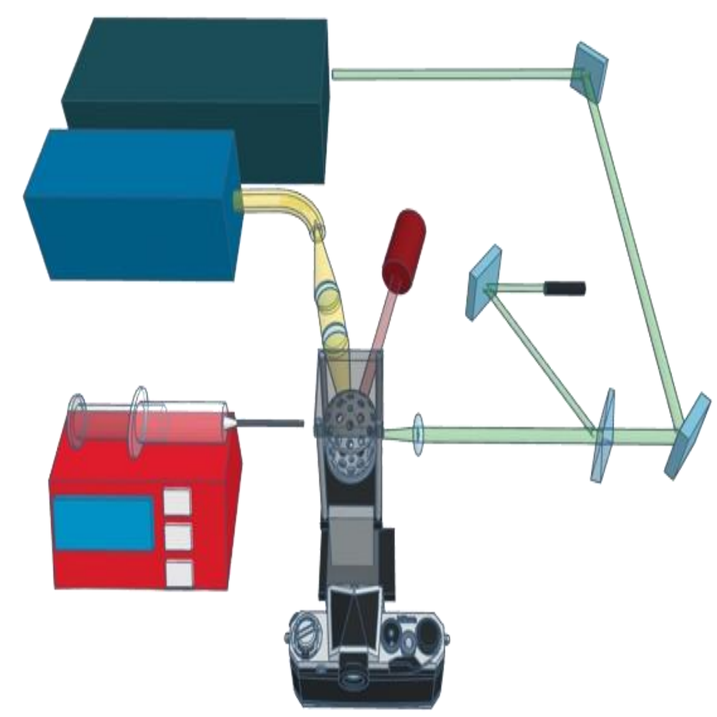
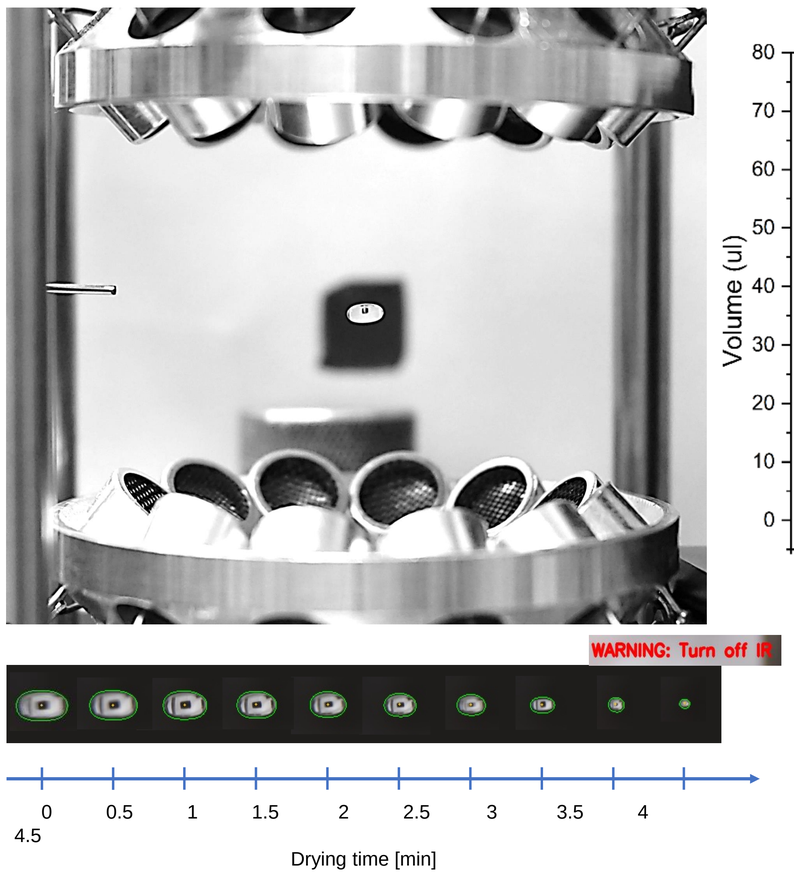
The analysis and monitoring of cadmium (Cd) and and lead (Pb) or other heavy metals in liquids is an important task for many fields [1]. Laser-Induced Breakdown Spectroscopy (LIBS) has challenges when analysing liquids due to different processes of the laser pulse-liquid interactions [2]. Different approaches to overcome these problems have been coupled to the LIBS technique [3]. A novel approach to sample the liquids for LIBS is the acoustic levitation of isolated droplets [4]. The radiation from a CW-IR laser leads to the evaporation of a levitated droplet and preconcentrates the analyte contents, providing a better LIBS signal [5].



Exp. Setup: Acoustic levitator, droplet deposition sys., monitoring camera, guiding, evaporation (IR) and ablation lasers, collection sys. and spectrometer.



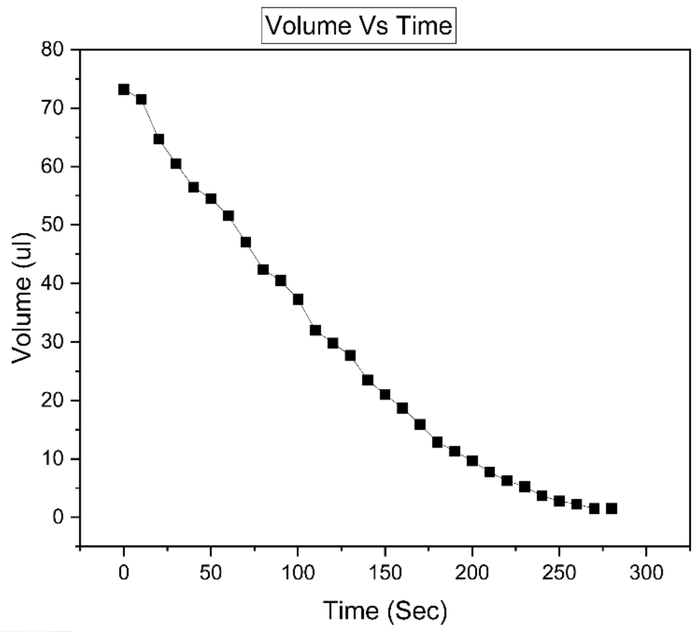
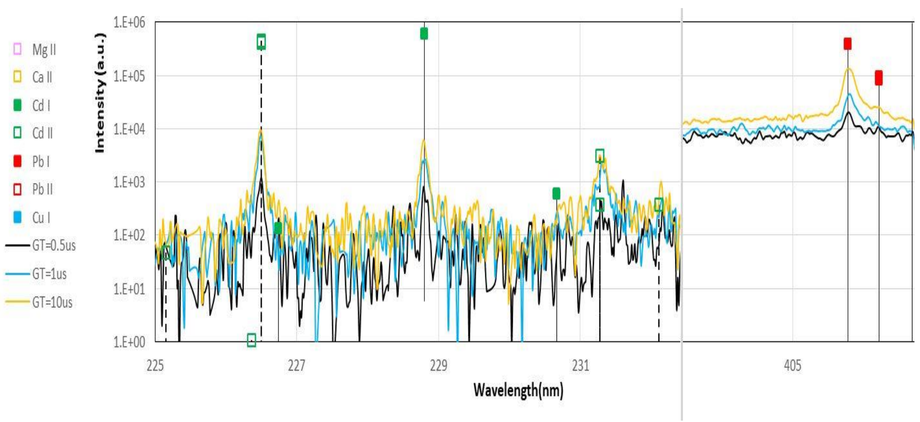
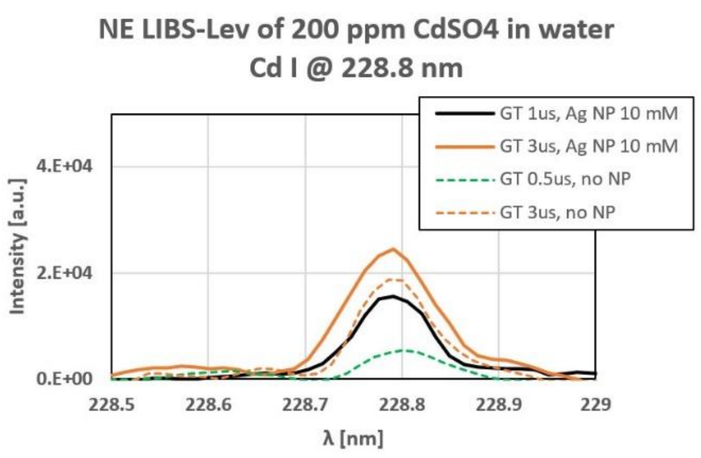
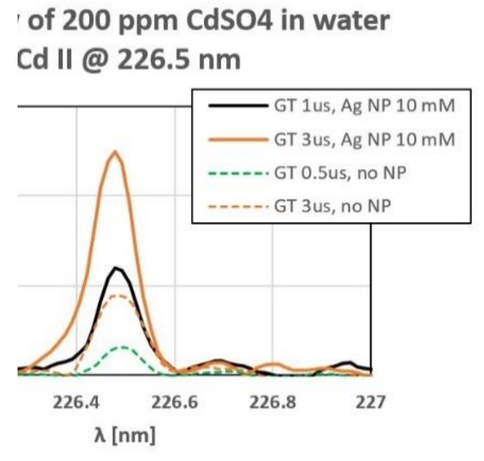


Fig. Droplet Volume vs Time.

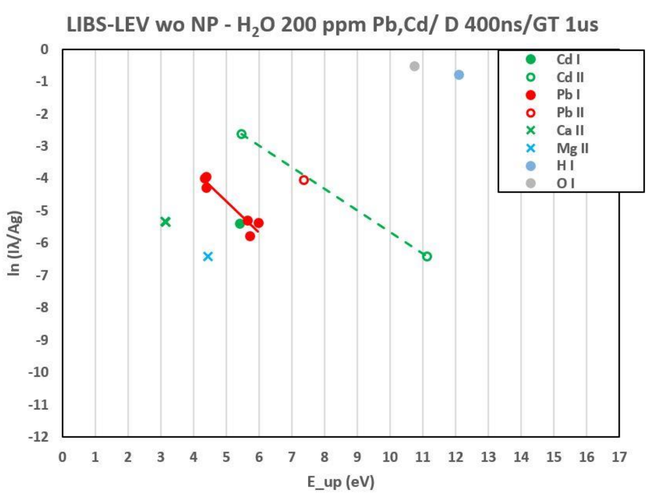
A method to enhance even further the water/alcohol-based liquids LIBS analysis is the use of nanoparticles (NP) [6]. NE LIBS-Lev was used in our group for comparing the enhancement of the signal from aqueous solution of CdSO4 and C4H6O4Pb to 200ppm and 20ppm from the heavy metals. The solution was mixed with a colloidal suspension of AgNP at 10 mM and 100 µM in order to study the effects of the quantity of NP. The spectra were recorded using an Echelle spectrometer (M5000, Andor Tech.) equipped with an iCCD camera (iStar DH743, Andor Tech.).

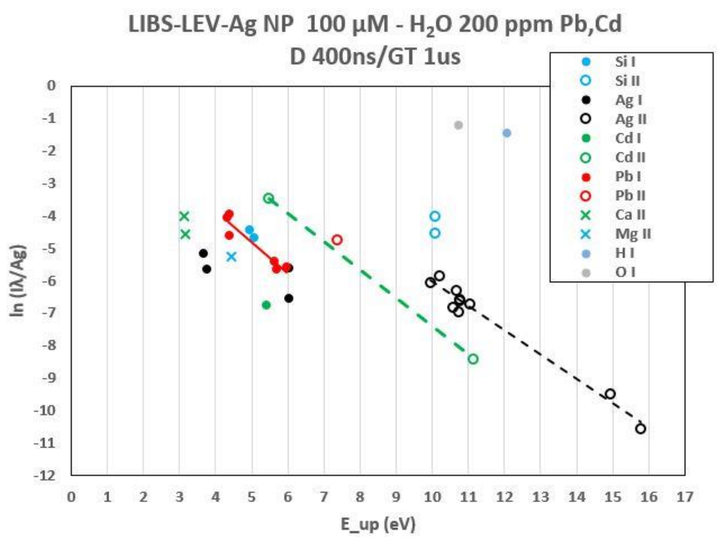


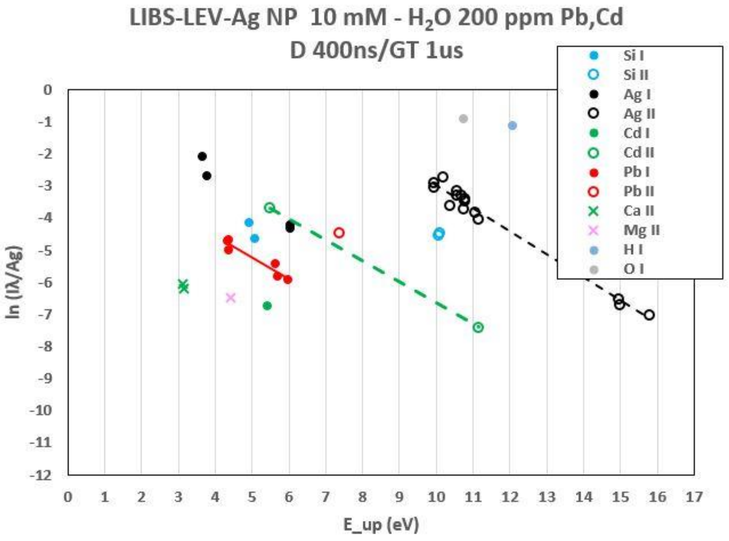




Figures above show the best observed spectral lines of heavy metals were at 228.8 nm (Cd I), 226.5 nm (Cd II), and 405.78 (Pb I) and on the right side the enhancement of 1.4x and 2.3x in the intensity of the Cd I and Cd II emission lines (which are strongest emission of Cd in the range from 200 – 850 nm). Figures below show the Boltzmann plots for elements observed in LIBS–Lev of aqueous solution of CdSO4 and C4H6O4Pb with and without Ag NP at two different molar concentrations. The real enhancement after normalisation was observed for Pb, Mg and Ca only at lower concentration of NP (100 µM).







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