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Atomization efficiency and photon yield in laser-induced breakdown spectroscopy analysis of single nanoparticles in an optical trap

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Abstract

Laser-induced breakdown spectroscopy (LIBS) was employed for investigating the influence of particle size on the dissociation efficiency and the absolute production of photons per mass unit of airborne solid graphite spheres under single-particle regime. Particles of average diameter of 400 nm were probed and compared with 2 μm particles. Samples were first catapulted into aerosol form and then secluded in an optical trap set by a 532 nm laser. Trap stability was quantified before subjecting particles to LIBS analysis. Fine alignment of the different lines comprising the optical catapulting-optical trapping-laser-induced breakdown spectroscopy instrument and tuning of excitation parameters conditioning the LIBS signal such as fluence and acquisition delay are described in detail with the ultimate goal of acquiring clear spectroscopic data on masses as low as 75 femtograms. The atomization efficiency and the photon yield increase as the particle size becomes smaller. Time-resolved plasma imaging studies were conducted to elucidate the mechanisms leading to particle disintegration and excitation.

Keywords:

Laser-induced breakdown spectroscopy, LIBS, Solid aerosols, Single particle analysis, Optical catapulting, Optical trapping, Atomization efficiency, Photon yield.

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