APPLICATION OF NANOPOROUS GLASS SUBSTRATES TO FACILITATE THE DIRECT TRACE ANALYSIS OF LIQUIDS BY LASER-INDUCED BREAKDOWN SPECTROSCOPY

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Abstract

Laser-induced breakdown spectroscopy (LIBS) is a powerful and flourishing analytical technique in atomic spectroscopy. Although LIBS is compatible with gaseous, aerosol and liquid samples too, it is mainly utilized for the analysis of solid samples. This is because all other samples types pose multiple challenges in terms of sensitivity and practicality. The analysis of (bulk) liquid samples are especially challenging because they are prone to focusing difficulties, splashing, plasma quenching, etc., leading to decreased limits of detection and reproducibility as well as substantially increased laser energy requirements [1]. To tackle these challenges, multiple approaches has been reported in the literature. Most of them rely on liquid-solid conversion, while others use specialized equipment to present the liquid as jets, films or droplets, etc. [2, 3]. Nevertheless, while eliminating some of the drawbacks of bulk liquid analysis, the approaches presented so far still fall short in either sensitivity, reproducibility or practicality compared to solid analysis.

In this study we present an alternative methodology for the analysis of liquid microsamples via LIBS by utilizing strongly hydrophilic, nanoporous glass as a substrate. The premise of this approach is that the capillary forces will drive any aqueous sample that comes in contact with the glass into the nanopores, creating a fine, two-phase structure with a solid glass frame that actually serves as the laser target. This structure has multiple advantages in practice: a.) a very small volume of liquid sample (5-10 μL) is needed for the analysis, b.) usual problems with bulk liquid samples don't apply, c.) the nano-scale structure ensures efficient laser coupling and the homogeneous distribution of the liquid sample, facilitating reproducibility.

A thorough investigation of this approach for direct liquid analysis was done, examining the analytical benefits and capabilities as well as the detection limits and reproducibility achievable.

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