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Exploring the Effect of Sample Properties on Spark-Induced Breakdown Spectroscopy

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ABSTRACT

Optical emission spectroscopy techniques such as laser-induced breakdown spectroscopy (LIBS) and spark-induced breakdown spectroscopy (SIBS) provide portable and robust methods for elemental detection in real-time. Laser-produced emissions are then used for quantitative and qualitative analysis of a sample material with applications in explosives detection. For both techniques, the main obstacles have always been signal intensity, accuracy, and sensitivity of detection. The main advantage of the SIBS method is more safe operation, while still maintaining the portability of the technique. In this study, detailed characterization of spark induced plasma, analyte emission intensity, plasma temperature, electron density, and plasma persistence has been studied for various metallic samples with varying physical properties. Target samples, including Mg, Al, Cu, Ta, Sn, Fe, Co, W, and Mo were chosen based on their diverse set of properties, including: melting point, boiling point, first ionization potential, and conductivity. The role of sample properties on temporal evolution of SIBS signal and plasma characteristics was studied by varying the spark energy from 30 mJ to 180 mJ. Certain parameters such as the conductivity of the material greatly affect the SIBS signal intensity output. Mechanisms of SIBS plasma evolution are discussed in the context of material properties and optimal signal detection approaches are proposed. Principle component analysis is used to determine the dominant material properties that affect the SIBS signal intensity and plasma properties in order to optimize the SIBS intensity in the future.

KEYWORDS

Breakdown Spectroscopy, Elemental Detection, LIBS, SIBS, Optical Emission Spectroscopy