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The signal quality improvement of laser-induced breakdown spectroscopy due to the microwave plasma torch modulation

摘要

我们提出了一种新的方法，通过将微波等离子体炬（MPT）与激光诱导击穿光谱（LIBS）结合，称为MPT-LIBS，有效解决了传统 LIBS 的局限性。使用低激光脉冲能量为 0.55 毫焦的铜样品对 MPT-LIBS 技术进行了评估。结果显示，Cu I 521.82 纳米线的增强因子超过 70，而 Cu I 324.75 纳米和 327.40 纳米线的增强因子超过了两个数量级。此外，所有铜谱线的相对标准偏差（RSD）均有所降低，特别是 Cu I 521.82 纳米线，从 11.48% 降低到 1.36%，这表明信号稳定性显著提高。利用共聚焦显微镜对测试样品进行表征发现，MPT-LIBS 的剥蚀区域仅为 LIBS 的 1.36 倍。Cu I 324.75 纳米线的检出限从 52.8 ppk 降低到 319 ppm。

关键词

激光诱导击穿光谱；微波等离子体炬；低能激光检测

Abstract

Here, we present a novel approach by integrating microwave plasma torch (MPT) with LIBS, referred to as MPT-LIBS, which effectively addresses the limitations associated with traditional LIBS. The MPT-LIBS technique is evaluated using Cu samples with a low laser pulse energy of 0.55 mJ. A remarkable enhancement factor of over 70 for Cu I 521.82 nm line is demonstrated, while that of Cu I 324.75 nm and 327.40 nm lines exceeding two orders of magnitude. Furthermore, the RSDs of all Cu spectral lines are reduced, especially for Cu I 521.82 nm, which is decreased from 11.48% to 1.36%. This indicates a significant improvement in signal stability. Characterization of the tested samples using con-focal microscopy reveals that the ablation area of MPT-LIBS is only 1.36 times of that of LIBS. The limit of detection of Cu I 324.75 nm line is reduced from 52.8 ppk to 319 ppm.

Keywords

Laser-induced breakdown spectroscopy; Microwave plasma torch; Low laser energy detection

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