

## **LIBS compared with more conventional plasma OES techniques – a review of applications and analytical performance**

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LIBS is one of several plasma – based Optical Emission Spectroscopy (OES) techniques for elemental analysis. Most LIBS applications are on direct solids analysis, therefore this presentation will focus on a comparison of LIBS with the two most common “conventional” OES techniques for solids analysis; spark OES and Glow Discharge (GD) OES.

The by far most common technique for elemental analysis of metallurgical samples is spark OES, and it has a long history since the end of the 19<sup>th</sup> century. The technique is characterised by excellent precision and detection limits; in addition it is robust, fast and requires very little sample preparation. In short, an excellent analytical technique! The samples have to be flat and electrically conductive, normally easily fulfilled in routine metallurgical analysis. In addition to bulk analysis of the metal, analysis of non-metallic inclusions (NMI) by evaluation of single sparks has emerged as a very important application. This technique, often called Pulse Distribution Analysis (PDA), lends itself to a direct comparison with corresponding LIBS methods. The pros and cons of both techniques will be discussed.

GD-OES is a plasma technique where the sample surface is gently sputtered by bombardment from energetic ions in the plasma. For this reason, it has become a highly capable technique for in-depth elemental profiling. It is for this type of application where a direct comparison with LIBS is most appropriate. In contrast to the spark, GD-OES can also be applied to certain types of non-conducting materials by powering the discharge with a Radio Frequency (RF) generator. A comparison of depth profiling with GD-OES and LIBS will be presented.

In the comparison of LIBS with the other plasma sources discussed here, a general conclusion is that for the applications where the “conventional” techniques are mainly employed, LIBS does not provide significant advantages in terms of better analytical figures of merit, nor is it more robust or cost-effective. The great advantage of LIBS is instead in its remarkable versatility, capable of applications not possible by any other technique. LIBS requires no sample preparation and is amenable to analysis of virtually any kind of sample material, of any size and shape. LIBS can be adapted from microscopic investigations to remote analysis > 100m from the equipment. LIBS can also be extremely fast, and is ideally suited to various industrial on-line applications. A number of on-line applications, particularly related to analysis of metal scrap, will be presented and discussed.