

Laser-induced breakdown spectroscopy (LIBS) in cultural heritage

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Laser-induced breakdown spectroscopy (LIBS) is a versatile technique that provides nearly instant elemental analysis of materials, both in the laboratory and in the field. This is done by focusing a short laser pulse on the surface of the sample, or object, studied and analysing the resulting spectrum from the laser-induced plasma. LIBS has been employed

the technique is applied in the context of cultural heritage studies.

This is primarily because of the lack, to date, of commercial instruments dedicated to heritage applications, but also in some instances, of its micro-destructive character.

How does LIBS work?

The fundamental principle underlying LIBS stems from the brief interaction – just a few nanoseconds – between a focused laser pulse and a target object. This concentration of light both in space and time (leading to irradiance values of the order of a few GW/cm^2) is key to the initiation of a process (known as ‘laser ablation’) that triggers the rapid formation of a microplasma plume just above the sample surface. Following the laser pulse, this microplasma persists for a few microseconds, emitting radiation that arises from the relaxation of its constituents (electrons, excited atoms and ions)

Introduction

Laser-induced breakdown spectroscopy (LIBS) was introduced as a potential analytical tool in the context of cultural heritage studies during the mid-1990s. It facilitates the rapid elemental analysis of samples or objects examined, with no need for any sample or surface preparation. Despite these attractive features, the use of LIBS is still not widespread among conservators or archaeologists.

and controlled through a laptop

artefacts from archaeological excavations
(Fig. 5).
Sampling: the technique can be used

review, *Spectrochim. Acta B*, 2019, 34, 81–103.

4 D. Anglos and V. Detalle, Cultural Heritage Applications of LIBS, in *Handbook of Laser-Induced Breakdown Spectroscopy*, ed. S. Musazzi and

Several commercially available LIBS instruments provide some spectral recognition features, while several research groups have developed custom-made software that enables simulation of emission spectra.

Conclusions – outlook

LIBS is a versatile technique that can be used in the characterization of many types of heritage materials, rapidly providing information on their elemental compositions. Being mobile, LIBS facilitates analysis at diverse locations and this can be valuable at several stages of archaeological research and conservation campaigns and studies. Close interactions between members of the heritage (archaeologists, historians and conservators) and analytical communities will be needed for exploiting the potential of LIBS.

Safety

The operation of laser equipment requires proper training and the use of protective eyewear.

Further reading

- 1 Various articles on LIBS analysis and instrumentation in: <http://www.spectroscopyonline.com/libs-0>.
- 2 The use of LIBS for the analysis of archaeological objects and artefacts: <http://www.science4heritage.org/COSTG7/booklet/chapters/libs.htm>.
- 3 A. Botto, B. Campanella, S. Legnaioli, M. Lezzerini, G. Lorenzetti, S. Pagnotta, F. Poggialini and V. Palleschi, Applications of laser-induced breakdown spectroscopy in cultural heritage and archaeology: a critical