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LIBS IN CULTURAL HERITAGE

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The analysis of archaeological samples is of great relevance in order to study the technology, origin and progressive evolution of civilizations. Chemical information extrated from raw materials used in ancient times and the technology employed in the production of archaeological objects turns fundamental for a better understanding of historic events. Metallic objects are among archaeological samples (ceramics, metallic pieces, pictures, rocks and sculptures) the most appreciated due to their shortage and intrinsic heritage value. The value acquired by archaeological metallic objects has resulted in that sampling is often restricted to museums, galleries of art and real environments. Due to these constrains, it would always be preferably the use of either non destructive inspection techniques or techniques that cause minimum damage to the sample.

LASER TECHNIQUE

Laser-induced breakdown spectroscopy (LIBS) has been extensively tested in the cultural heritage field as an advanced tool in surface cleaning of art works, as well as in the characterization and restoration of pieces and objects of cultural interest. Archaeological samples inspected include metals, ceramics, pictures, rocks, marbles and documents and manuscripts. LIBS is based on the laser-matter interaction when a laser pulse of high power impacts the sample surface to generate a microplasma of high temperature and electron density.

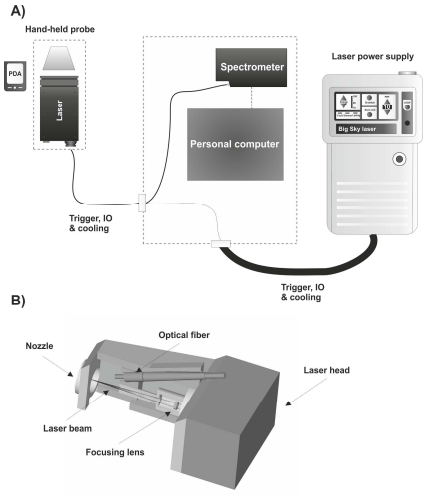

Figure 1. Portable LIBS instrument employed for the in-situ characterization of archaeological samples.

Pulses from a laser source are focused on the sample using an appropriate optical configuration. Then, the plasma light (containing the analytical information concerning the sample) is collected and guided to the detector. The characteristic atomic emission peaks in the LIB spectrum enable identification of the elements contained in the material. In the case of the instrument employed. Figure 1 shows a Schematic diagram of a portable LIBS instrument used for the analysis of geological samples.

LIBS ADVANTAGES

Advantages of laser-induced breakdown spectroscopy (LIBS) for geological exploration:

- No sample preparation
- Analysis at atmospheric pressure and room temperature
- No sample restriction in size and shape
- In-situ analysis in real environments
- Good lateral and in-depth resolution
- Fast analytical response
- Qualitative and quantitative analysis
- Spot size in the order of a few micrometers in diameter
- No destructive analysis
- Capability for remote and stand-off analysis

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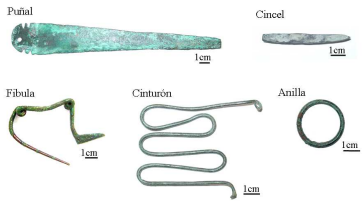
Figure 2. Picture taken during the analysis in the Cathedral of Malaga.

LIBS FOR CULTURAL HERITAGE APPLICATIONS

The versatility of LIBS has allowed the design, building and development of fieldable instruments, which integrate analytical technologies into mobile platforms that may be moved to any real-world environment, therefore allowing the in-situ analysis of the sample of interest. This feature is extremely important when the assets are inaccessible to classical analytical settings. Figure 1 shows a Schematic diagram of the portable LIBS system designed in UMA.



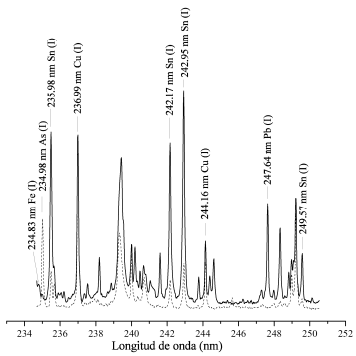


Figure 3. Chemical characterization of a metallic artifact belonging to the Iron Age.

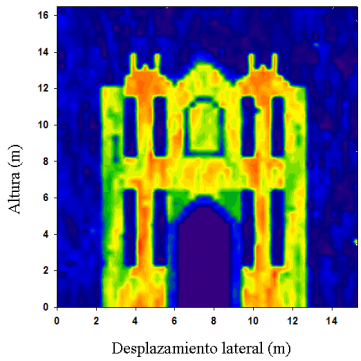


Figure 4. Chemical image obtained in the portal of the northern facade for Si/Ca in the Cathedral of Malaga.

Figure 5. Chemical characterization of a piece of gypsum from Polynesia.

Figures 3-5 shows some LIBS applications for the chemical characterization of metallic artifacts such as iron, bronzes and jewelry objects (Figure 3), in-situ analytical assessment of historical buildings such as the Cathedral of Malaga (Figure 4) and in general any cultural heritage object independently of its composition, shape and size (Figure 5).

CONCLUSIONS

The minimum damage of the sample surface and its easy portability makes laser-induced breakdown spectroscopy an ideal method for the identification and quantitative analysis of archaeological samples.

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