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A support of restoration intervention of the bust of St. Gregory the Armenian: Compositional investigations by laser induced breakdown spectroscopy

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Abstract

Laser induced breakdown spectroscopy was employed in the restoration process of the bust of St. Gregory the Armenian. It was applied to carry out elemental chemical analyses of different details of the bust. The analyses showed that all the investigated pieces are covered by polluted layers, rich mainly in calcium which can be removed by laser ablation. The investigations performed on the cleaned surfaces confirm that the hair is composed essentially of silver and the stole of copper and that no foils were added during the stages of artwork realization. The interesting finding is that the decorative coating of the stole was realized in gold, instead of the supposed brass.

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1. Introduction

Due to the historical and cultural interest, the 'Sigismondo Castromediano' Provincial Museum in Lecce was commissioned to carry out the restoration of the bust of St. Gregory the Armenian, guarded in the diocese of Nardò (in province of Lecce) [1,2]. With the aim of valuating the probable alteration of the artwork, studying its decay evolution and determining the more suitable restoration procedure, a careful investigation of St. Gregory's bust elemental composition in all its constituent parts was performed by laser induced breakdown spectroscopy (LIBS).

The manufactured artwork is composed of precious materials. The experts hypotisized that face, hair and hands were made in fused silver, the mantle was realized by silver foils mounted on a wooden trunk-conic structure, the mitra and the cross were in fused brass and the stole in copper with a decorative

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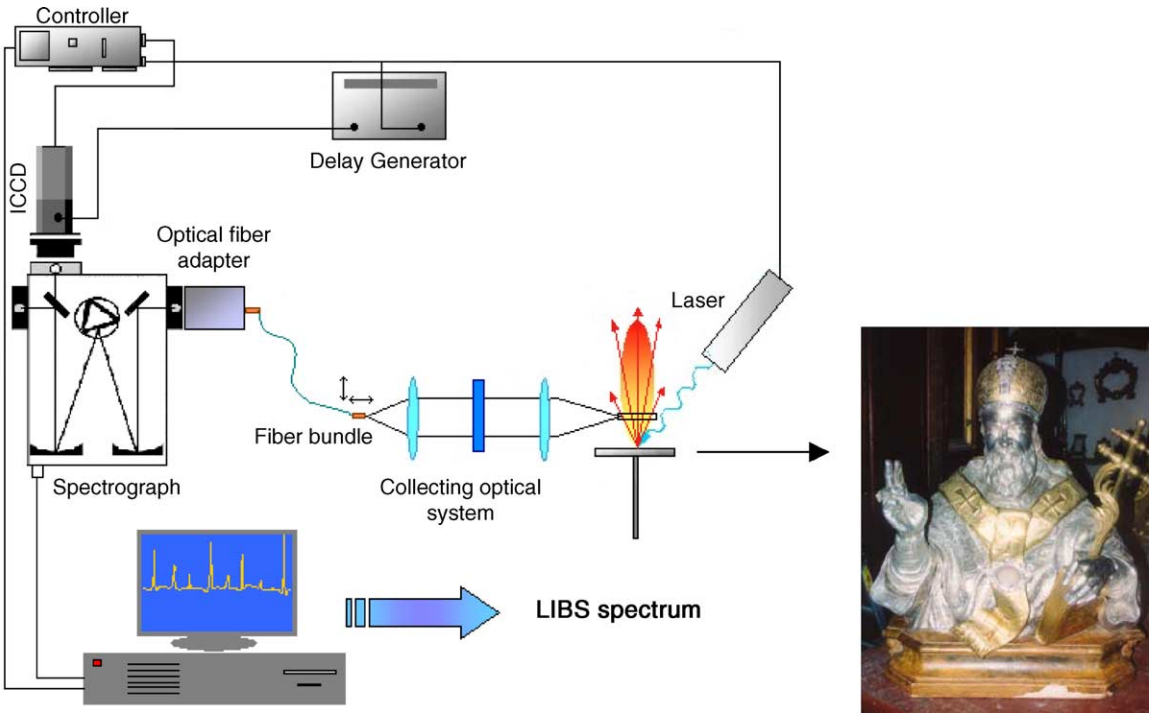

Fig. 1. Experimental apparatus for LIBS analyses. Bust of St. Gregory the Armenian (1716) before restoration (at right).

pinchbeck coating. In the centre of the stole a small glass reliquary is inserted (see Fig. 1).

This manufactured object involves forms of decay, such as the presence of contaminants both on the silver parts and on the elements in copper and brass.

The bust has already undergone a restoration, as it is visible through the presence of yellowed putty and gauzes soaked of aged adhesives.

Prior to restoration operations, several pieces of St. Gregory's bust were analysed by LIBS.

Application of LIBS in the diagnosis of the state of artwork preservation and as support of the restoration process is a promising method. Among the different techniques for physical, chemical and structural artwork characterization, LIBS can be used to determine the elemental composition of a sample [3–6] with simplicity and rapidity. This diagnostic technique is an almost non-destructive method and it avoids sampling and sample preparation letting in situ elemental analyses, in contrast with the traditional artwork investigation techniques. This LIBS capability allows us to carry out measurements on quite large and cumbersome pieces.

In the present work, LIBS is used to perform a qualitative investigation of the artwork in order to determine the metal alloys used in the manufactured bust and to test both the experts' hypotheses on the different kind of used materials and the status of restoration carried out on the artwork.

2. Experimental and methodologies

A sketch of the experimental apparatus for LIBS investigations is reported in Fig. 1.

A 308 nm XeCl excimer laser beam (LPX 315i, Lambda Physik), with a 30 ns pulse duration, was focused by a quartz lens of 200 mm focal length onto the surface of several pieces of the bust of St. Gregory the Armenian, inducing the formation of a plasma plume in air. Laser fluence was $\leq$10 J/cm^2.

To identify the emitting chemical species present in the laser-produced plasma, the plume was imaged by an optical system of two 200 mm focal length lenses on a bundle of 19 fused-silica optical fibers with a 200 μm core.