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Towards a portable X-ray luminescence instrument for applications in the Cultural Heritage field*

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Abstract. Analytical techniques based on luminescence properties of materials have proved to be useful in the study of artistic and archaeological materials. For example, iono-luminescence (IL), in conjunction with ion beam analysis (IBA) techniques, and cathodoluminescence (CL), coupled with optical microscopy or scanning electron microscopy (SEM), are important for identifying mineral phases and provenance studies. X-ray luminescence (XRL) has been used on Cultural Heritage less than other luminescence techniques; we therefore investigated its potential in this field. The first developed setup, necessarily to be used in the laboratory, was tested on a provenance study of the lapis lazuli "Savoy Collection", kept by the Regional Museum of Natural Sciences in Turin. Very interesting results were obtained: while some samples were labelled as Chilean origin (or simply no attribution), XRL spectra clearly excluded that particular provenance for any specimen of the collection. Although this approach has given valuable information, the potentiality of the technique has not yet been fully exploited due to lack of portability, a great limitation for characterising ancient artefacts. We therefore upgraded the sensitivity of our detection setup, in order to respond also to lower signal levels obtainable with portable X-ray sources. The first results are encouraging and comparable with those obtained with non-portable setups.

1 Introduction

The luminescent properties of a material can give useful information about the interpretation of its elemental composition and/or about its structure. Luminescence consists in the emission of photons from the material (usually in the UV-VIS-NIR interval), excited by energy that can be released onto the material itself by different kind of probes (*e.g.*, electrons, ions, photons, heating, etc.) [1].

The techniques based on luminescence are widely employed in different fields and especially in the material science characterization [2,3]. Their definition depends on the probe used to induce the luminescence effect: electrons for cathodoluminescence (CL); ions for ionoluminescence (IL or ion-beam–induced luminescence (IBIL)); X-rays for X-ray luminescence (XRL); visible photons for photoluminescence (PL) and optical stimulated luminescence (OSL); heating for thermoluminescence (TL).

In the last decades, many of these techniques found applications also in the Cultural Heritage field: TL and OSL for dating archaeological materials [4,5] while CL, IL and PL for the characterisation of artistic and archaeological materials [6,7]. The best materials to be analysed are stones and gemstones, for which luminescence properties can provide in-

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