Ion Beam Analysis for the Investigation of a Polychrome Wooden Statuette from Ancient Egypt

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INTRODUCTION

A large production of wooden statuettes can be included among Ancient Egypt treasures. The wooden surfaces are often decorated with painted layers of different colors, whose specific sequence had not only aesthetic purpose, but also a ritual meaning, since the figurines were frequently part of grave goods [1].

Such kind of statuettes have gained increasing interest for archaeometrical studies, with the application of different techniques, such as SEM-EDX, XRF and Raman spectroscopy, and possibly with non-invasive or non-destructive methods [2,3].

In this work a preliminary qualitative characterization with both PIXE and ionoluminescence (IL) was achieved for the study of the different layers and pigments, thanks to the availability of small fragments spontaneously detached from the surfaces of a heavily damaged statuette, dated back to 1100-1300 BCE. In order to clearly discriminate the different painted layers, in this kind of study a very small beam size is needed, generally in the order of few microns.

The simultaneous acquisition of PIXE and IL signals from the same area allows to collect both elemental and structural information on the material under analysis. Moreover, the very low values for limit of detection reachable with PIXE permit as well to quantitatively determine the concentration of trace elements, useful in future investigations on the material provenance.

EXPERIMENTAL

The two fragments retrieved from the wooden statuette (C1 and C2) were prepared as cross sections: they were firstly embedded in resin, then polished until the sequence of painted layer was exposed. Preliminary observations were obtained with optical microscopy and SEM, producing images useful as reference for subsequent measurements. The cross sections surfaces were later carbon-coated to avoid the charge of the material during ion beam analysis.

μ-PIXE and μ-IL measurements were carried out at the AN2000 microbeam facility using 2 MeV protons. The focused beam was about 5 μm in size and the current detected on sample during acquisitions was ~ 1 nA.

The IL signal was acquired via a collecting lens fixed inside the analytical chamber and connected to a QEPro Ocean Optics cooled spectrometer through two optical fibres, one inside and one outside the chamber, and a
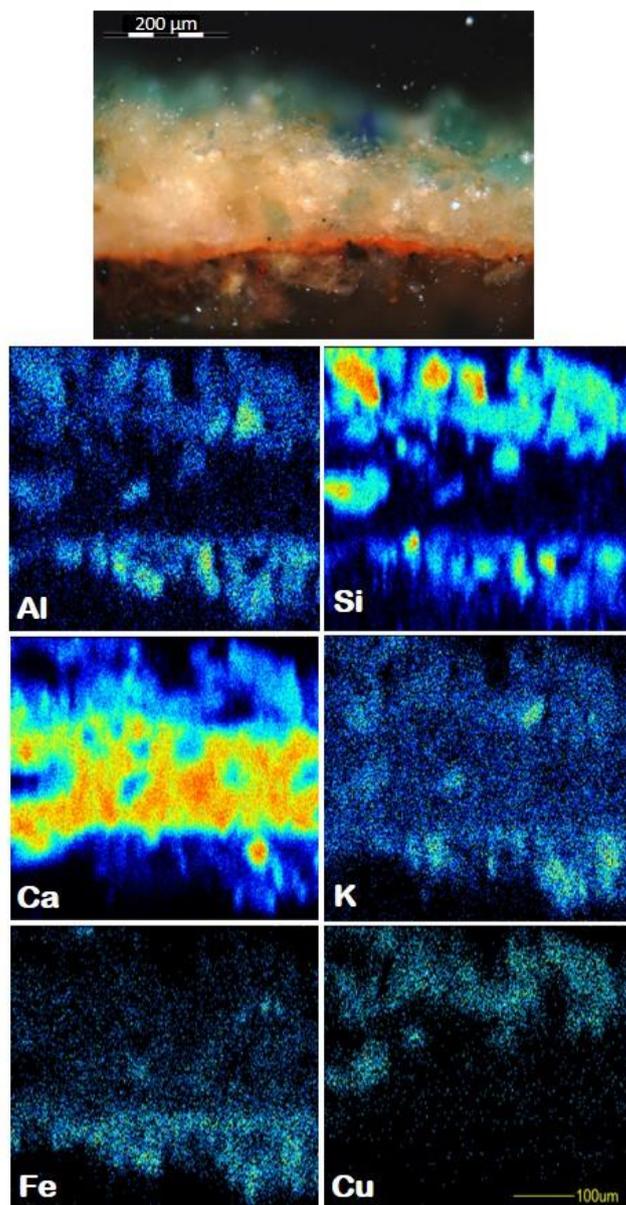

Fig. 1. Optical microscope image of the sample C1 in cross section (top) and μ-PIXE acquisitions on a $500 \times 500 \ \mu m^2$ scanned area. All reported PIXE maps are equally scaled in dimension and highlight the layering sequence. Color scale is from black (minimum value) to red (maximum value).