

XMF 104 X-ray Micro Analyser

X-ray Micro Analysis of Ancient Paintings

Introduction

An interesting application of micro XRF is discussed in the present Application Notes.

It mainly focuses on the utility of Micro XRF Analysis in the investigation of ancient paintings. The two main objectives of the present work are: the study of the painting technique and the assessment of surface conservation state.

A proper study of art conservation is very important and critical from archaeological and anthropological points of view as it is necessary to distinguish and characterize the repainting and the restoration materials.

This study discusses about the sample preparation technique adopted and also illustrates the utility of Unisantix XMF-104 X-Ray Micro Analyser for such applications.



**Unisantix XMF-104
X-Ray Micro Analyser**



Application Background

An interesting application of micro XRF discussed in the present study highlights the investigation of frescoes by Filippo Lippi in Prato's Cathedral. The frescoes, painted between 1452 and 1465, depict the life of S. Stefano and S Giovanni Battista.

It is evident that several details have been painted with tempera technique (pigments dispersed in egg emulsion) and, furthermore, many relief decorations outline the figures, the vestments and other details are made with gilded wax.

The paintings undertaken for the present study are given in Fig 1.



Figure 1: Register of St. John life: halo of Jesus Christ is decorated with small wax gilded points (left). Register of St Stephen life: the vestment of a girl becomes more precious due to wax gilded decorations (right)

Instrumentation

Measurements were performed using a Unisantis XMF-104 X-Ray Micro Analyser, equipped with a 50 W Molybdenum tube and a high resolution two-stage Peltier cooled, compact Si-PIN detector.

This reduces the dimensions of the instrument significantly and also eliminates the need for cooling of the detector with liquid nitrogen.

The XMF uses a Polycapillary focusing lens which provides the analyst an intensely focused x-ray beam of very small diameter. Typical dimensions of the focal spot at the exit of the lens vary between 50 and 250 microns.

Sample Preparation

Considering the wide extension of the frescoes, more than 30 areas were examined and sampled in order to comprehensively investigate the compositional characteristics of the painting layers.

As reported earlier, many decorative details have been made in relief with gilded wax. Two examples are reported in Figure 1, where wax decorations enrich the halo of Christ and a vestment. Furthermore, sky in the vault is covered by gilded relief stars.

Different wax residues are visible on the painted surface, overlaid to a red fresco painted background. Background itself was probably green and blue, as it was a lake landscape, but, nowadays, these painted layers have been lost, leaving uncovered the red "fresco" base called "morellone".

Micro samples were collected from this area, in order to characterize the wax material. The samples have been mounted on a glass capillary (figure 2), as a sample holder, so that it was possible to study different sides of the fragment.

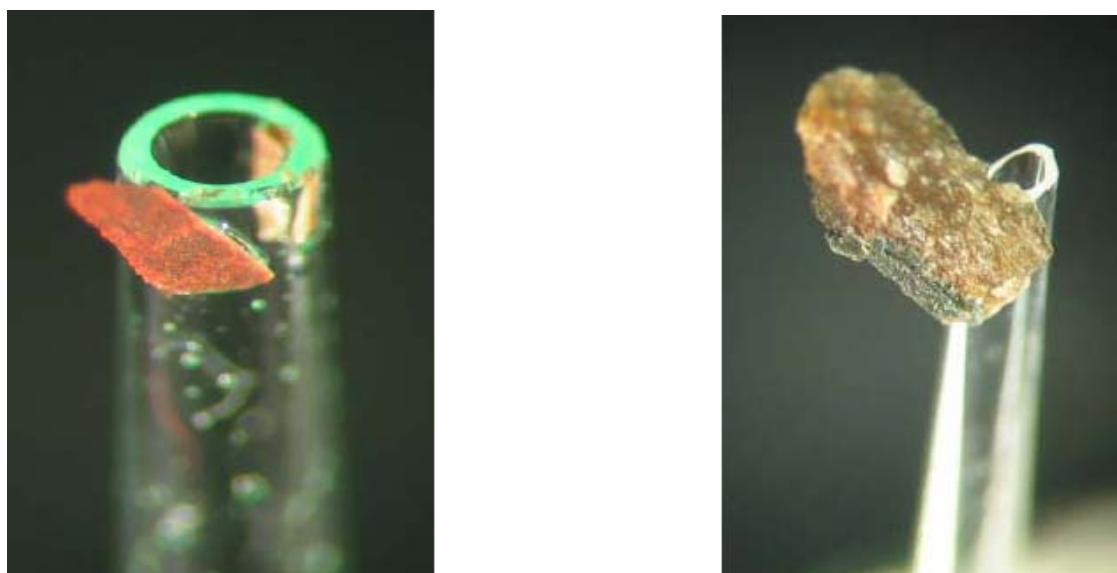


Figure 2: Micro samples mounted on a capillary for μ -XRF and μ -XRD measurements

Results

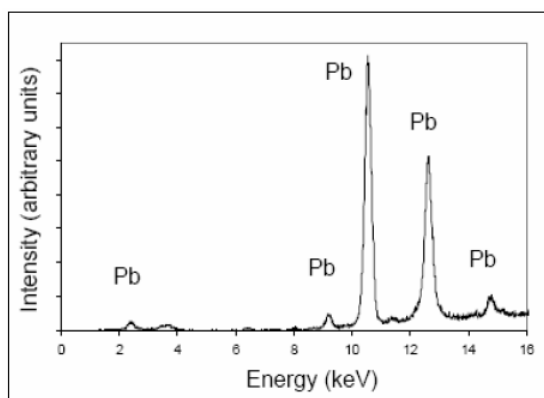


Figure 3: Micro-XRF analysis of a black micro-sample of the wax decoration

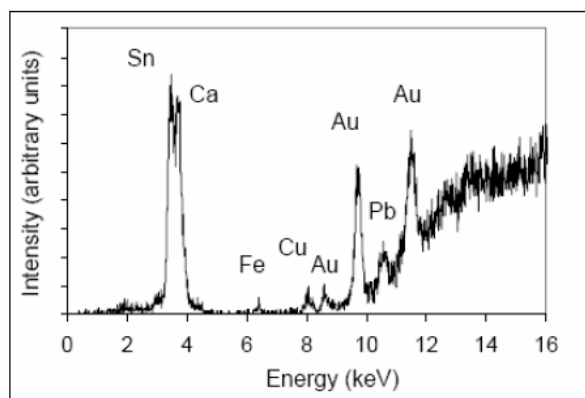


Figure 4: Micro-XRF analysis of the residue of gilding of the wax decoration

Conclusion

Micro-XRF analyses obtained from the samples as given in Fig. 3 and Fig. 4. show the presence of Ca, Fe Cu,Au, Pb, Sn. The percentage of the elements strongly changes in different points of the same fragment. However, it is interesting to note that in the black area almost only Pb was detected (Fig.3). Further study of the stratigraphy of the gilded decorations are still in progress.

Thus, Micro-XRF represents an invaluable tool in non-destructive diagnosis on Cultural Heritage. The study of artworks has a great importance because it reveals information that is of general historical interest in the knowledge of artistic materials that were used and available at a certain period, in a particular region and for disseminating new methods. On the other hand, an important purpose of this monitoring is to help the conservators to assess the deterioration causes and optimize the conservation methods.

Other unique advantages of Unisantis XMF-104 are:

- ◆ No counter gas
- ◆ No external water cooling for x-ray tube
- ◆ Small footprint
- ◆ Low power tube

Reference:

The above study was carried out at Chem4Tech, University of Brescia, Italy under the expert guidance of Dr. L. Depero and her research team.

Unisantis S.A. is a global leader in the development and manufacture of innovative X-Ray analytical instrumentation, complete solutions and software for structure and elemental analysis using proprietary Kumakhov's optics best known for accurate beam collimation. Success in research has enabled Unisantis S.A. to develop new cutting - edge X-ray technology, applications and products for the market. Our products have particular applications in material characterization, life science and industrial analysis.

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