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XRF

Non-destructive large area elemental map imaging on the painting "Flower Vase with Thistles" using the XGT-9000SL

Application Note

Archeology
XGT 26

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Abstract: Pigments are important clues to the historical background of artworks. This application note introduces elemental map imaging performed on Vincent van Gogh's oil painting "Flower Vase with Thistles" using the XGT-9000SL. The results reveal that elemental compositions of the pigments used on the painting were different from ones previously reported to have been used by van Gogh. It suggests that this painting was a replica of the artwork.

Keywords: Archeology, arts, painting, micro-XRF, pigment identification, large area elemental map imaging

Introduction

With the development of chemistry, pigments have become increasingly diverse. Some pigments are used only in certain times and are no longer used in later times. Therefore, we can estimate the period when artwork was created through identification of the pigments.[1,2,3] In the case that pigments used on artwork are not ones that existed in the period when the work was thought to have been created, it is likely to be a reproduction from a later era.

Micro-XRF is an effective analytical technique for pigment identification on archaeological paintings thanks to its non-destructive approach and capability for large area analysis. Unlike SEM-EDS, micro-XRF doesn't need sample pretreatment, such as applying a conductive coating to non-conductive samples such as paintings. In this application note, elemental map imaging was carried out on a painting "Flower Vase with Thistles" known as Vincent van Gogh's artwork using HORIBA XGT-9000SL, a super-large chamber X-ray analytical microscope.

Figure 1. The unframed oil painting "Flower Vase with Thistles" (size: 409 mm x 318 mm) analyzed in this application note.

Sample Information

"Flower Vase with Thistles" is one of the famous oil paintings of Vincent van Gogh. The painting was known to be created in 1890, the last year of van Gogh's life. We analyzed a painting that is suspected as a replica of the artwork made in a later era.

XGT-9000SL

HORIBA XGT-9000SL is an X-ray analytical microscope with a super-large chamber whose available chamber capacity is 1030 mm (W) x 950 mm (D) x 500 mm (H). It is an energy-dispersive X-ray fluorescence spectroscopy equipped with selectable micro-probes from 1.2 mm down to 10 µm. It is equipped with a motorized XYZ stage, which enables elemental map imaging. The maximum mapping area is 350 mm x 350 mm on a 500 mm x 500 mm sample. The XGT-9000SL has X-ray shields complying with the radiation safety requirement of IEC-61010-1. The large capacity and full shielding make it possible to perform non-destructive large area analysis with the XGT-9000SL without compromising user safety.

(a)

(b)

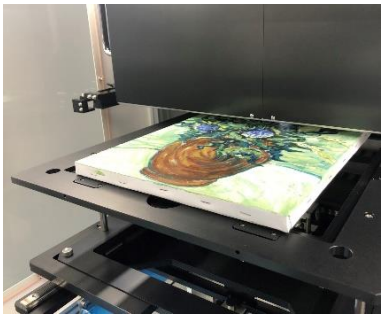

Figure 2. (a) HORIBA XGT-9000SL, a super-large chamber model. (b) Sample mounted inside the analysis chamber.

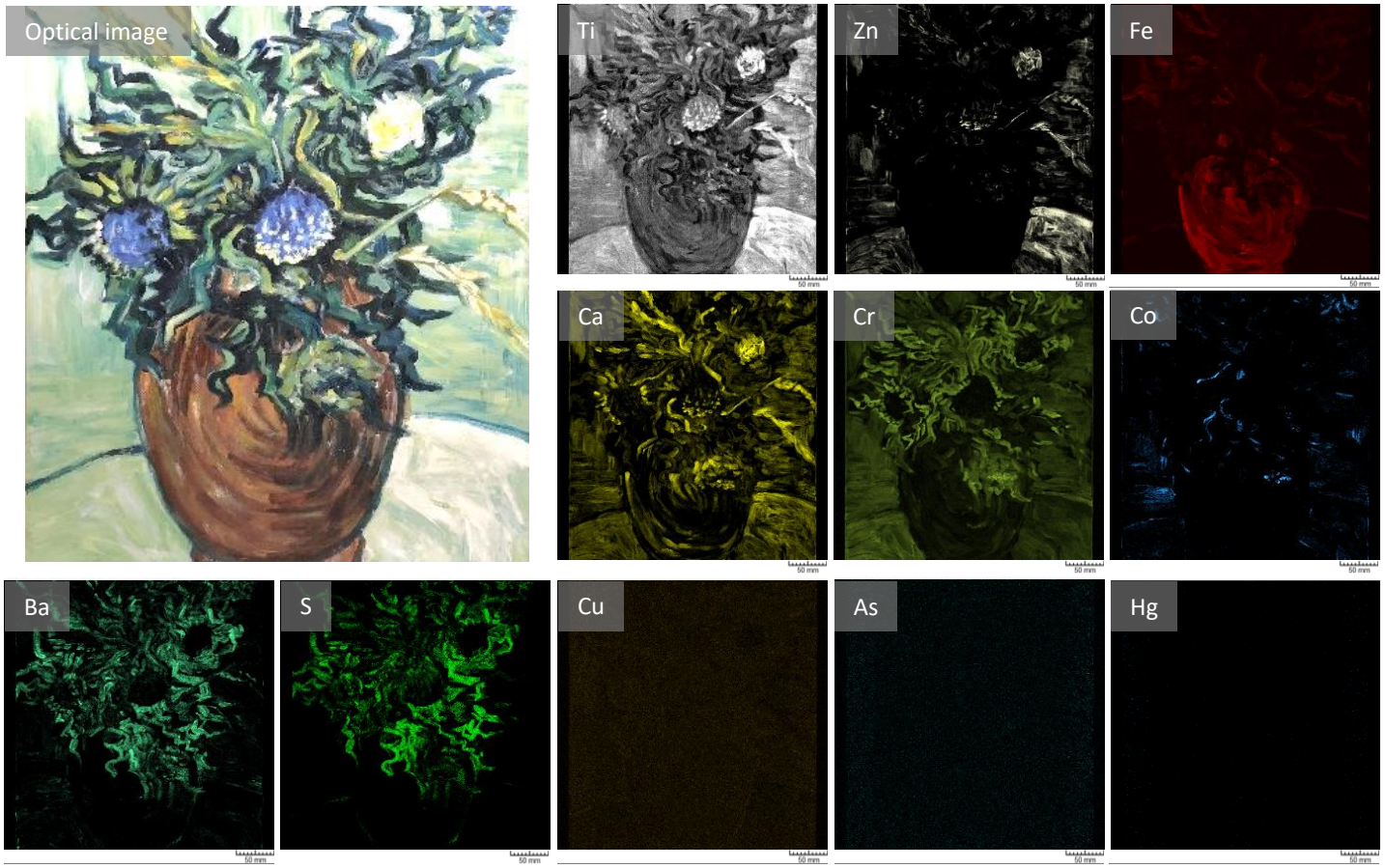

Figure 3 Optical image and elemental map images of a 350 mm x 350 mm measurement area on the painting “Flower Vase with Thistles” acquired using XGT-9000SL.

Measurement condition and result

Elemental map imaging was performed using the XGT-9000SL on a 350 mm x 350 mm area of the painting, covering almost the entire painting. The measurement was conducted with a 100 µm ultra-high intensity probe in ambient condition, using 50 kV voltage and 1000 µA current at the primary X-ray generator.

The results of elemental map imaging (Figure 3) show that Ti, Zn, Fe, Ca, Cr, Co, Ba, and S were detected on the painting. Ti was distributed on the background area of the painting and white areas of the flowers. Zn was detected particularly in white color areas such as the right-bottom area. Fe was detected in the brown vase area. Among leaf areas, Ca was detected on yellow leaves, Cr was detected on light green leaves, Co was detected on blue leaves, and Ba and S were detected together on dark green leaves. The remarkable point is that previous research reported that van Gogh often used Emerald Green ($Cu[C_3H_3O_2]\cdot 3Cu[AsO_2]_2$) for green and Vermillion (HgS) for red.[4] However, any distributions of Cu, As, Hg were not detected on the painting measured in this application note. Thus this result suggested that this painting was not the one drawn by van Gogh.

Conclusion

XGT-9000SL is a powerful non-destructive analytical instrument to understand the elemental composition of pigments used on individual color areas within a painting. It reveals the origin of archaeological paintings through this elemental approach. In this application note, the painting “Flower Vase with Thistles” has been shown to be a replica, analyzed within a super-large sample chamber without any destructive preparation of the sample.

References

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