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The Power of Micro-XRF in Gemology – Part 2: Non-destructive Screening to Find an Imitated Emerald Product

Application Note

Gemology
XGT31

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Abstract: In this application note, we introduce a non-destructive screening method for gemstone counterfeit analysis using a HORIBA XGT-9000 X-ray Analytical Microscope. We analyzed two emeralds, and without any sample destruction, we could successfully determine that one of them was an imitated product made of a green-colored glass.

Keywords: Gemology, gemstone, emeralds, counterfeit analysis, EDXRF, micro-XRF.

Introduction

Emerald is a gemstone, which is famous for its rich and distinctly green color. However, because of the unique color, people are easily deceived by imitated products, such as green-colored plastics or green-colored glass.

Emerald gemstones are categorized into the beryl mineral family whose chemical structure is $Be_3Al_2(SiO_3)_6$[1] and the unique green color is derived from trace amounts of iron, chromium and/or vanadium[2]. Therefore, the elemental composition is key to distinguish imitated products from real emerald gemstones.

In this application note, we analyzed two emerald jewelry pieces to show the capability of micro-X-ray fluorescence (micro-XRF) as a fast and non-destructive screening tool for gemstone counterfeit analysis.

Figure 1. Photo of the two emerald jewelry pieces which we analyzed in this application note

The XGT-9000 X-ray Analytical Microscope

The XGT-9000 X-ray Analytical Microscope (Figure 2) is an energy dispersive X-ray fluorescence microscope (micro-XRF) with an upper irradiation with micro-spot size and a motorized XYZ stage. It allows elemental map imaging to cover multiple samples at once.

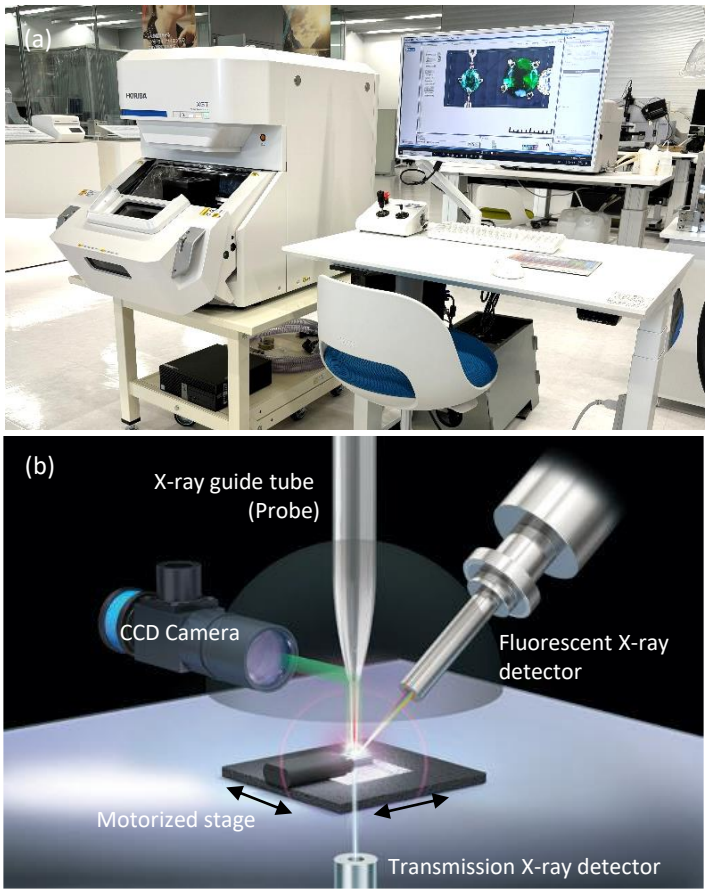

Figure 2 (a) Instrument set-up of the XGT-9000 X-ray Analytical Microscope. (b) The schematic diagram of the optics in the XGT-9000.

Sample Information

We purchased two emerald jewelry pieces: One from a discount retailer (Fig.1 and Fig.3, left) and the other one from a famous jewelry brand (Fig.1 and Fig.3, right).

Measurement and Result

We placed both jewelry pieces in the sample chamber, without sample pretreatment. We performed elemental map imaging using the XGT-9000 Expert with a 100 µm ultra-high intensity probe at 50 kV and 800 µA of the primary X-ray generator. The analysis was carried out in 10 minutes under full-vacuum condition.

Figure 3 shows the optical image and the elemental map result from the XGT-9000. Because of the manuscript's space limitation, we present some popular elements of emeralds in this application note.

As shown in Figure 3, the sample on the left side showed clear distribution of Si, but it didn't show clear presence of Al, although Al is one of the main elements of the beryl mineral family ($Be_3Al_2(SiO_3)_6$). Unexpectedly, the peaks of Na, K, Ca, Zn, Cu and As were detected in the spectrum of the sample (The spectrum data are not shown here). Na, K, Ca and Zn are reported to be possible elements of a glass material for imitated gemstones[3], and As and Cu are possible elements in an artificial green pigment, like an "emerald green" pigment, whose chemical structure is $Cu(C_2H_3O_2)_2 \cdot 3Cu(AsO_2)_2$. It suggests that the jewelry was an imitated emerald made of a green-colored glass. On the other hand, the sample on the right side showed clear distribution of Si, Al, Fe and Cr which are the common elements in emerald gemstones.

Conclusion

Our result successfully revealed an imitated emerald made of a green-colored glass. Although we did the imaging on two samples this time, we could show the power of micro-XRF as a non-destructive screening tool for counterfeit analysis on multiple samples at once.

References

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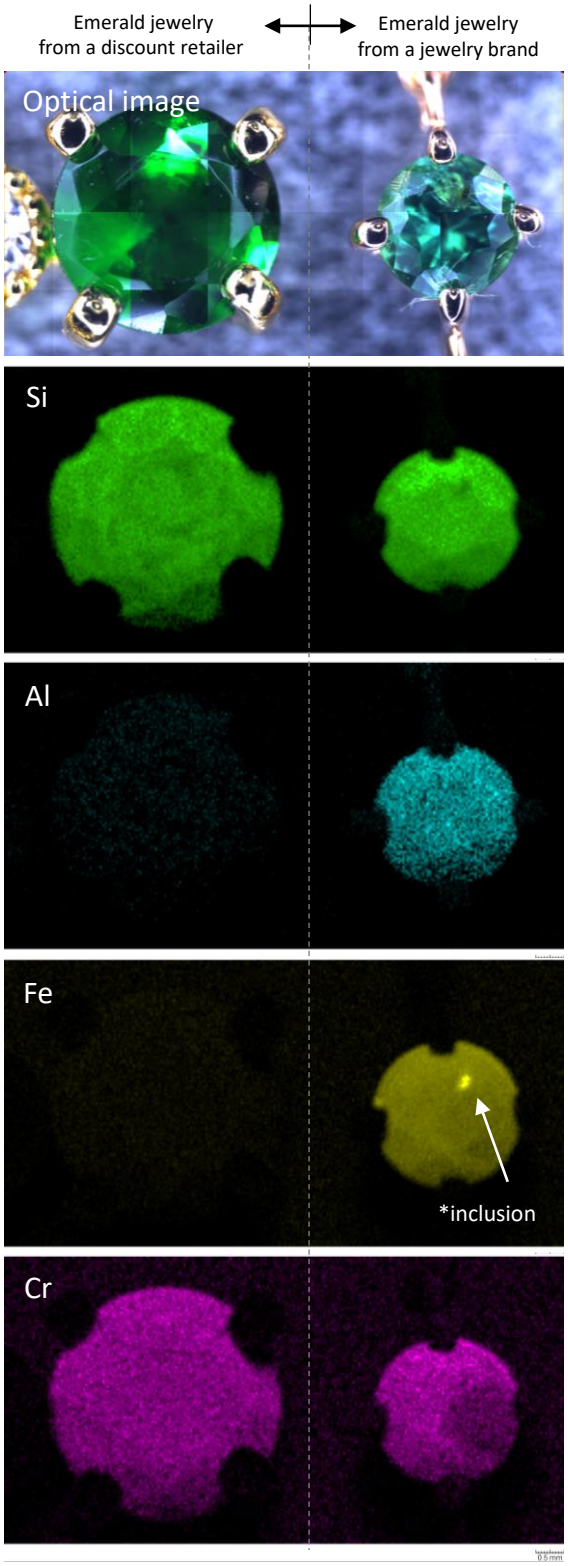

Figure 3. Elemental map imaging result by the XGT-9000.
- Left: a jewelry purchased at a discount retailer.
- Right: a jewelry purchased from a famous jewelry brand.

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