Non-invasive on-site Raman and XRF study of the 17th-18th century painted enamelled Chinese metal wares and porcelains: Comparison with French enamelling technology

Philippe Colomban, Burcu Kirmizi, Bing Zhao, Jean-Baptiste Clais, Michele Gironda, Vincent Cochet

To cite this version:

Philippe Colomban, Burcu Kirmizi, Bing Zhao, Jean-Baptiste Clais, Michele Gironda, et al.. Non-invasive on-site Raman and XRF study of the 17th-18th century painted enamelled Chinese metal wares and porcelains: Comparison with French enamelling technology. 5th International Conference on Innovation in Art Research and Technology (inArt 2022), Jun 2022, Paris, France. hal-03964497

HAL Id: hal-03964497
https://hal.science/hal-03964497
Submitted on 1 Feb 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Non-invasive on-site Raman and XRF study of the 17th-18th century painted enameled Chinese metal wares and porcelains: Comparison with French enamelling technology

Philippe Colomban1, Burcu Kirmizi2, Bing Zhao3, Jean-Baptiste Clais4, Michele Gironda5, Vincent Cochet1

1 Sorbonne Université, CNRS, MONARIS UMR8233, 4 Place Jussieu, 75005 Paris, France
2 Yıldız Technical University, Dept. of Conservation and Restoration of Cultural Property, Beşiktaş 34349 Istanbul, Turkey
3 CNRS, College de France, CRCAO, UMR1155, 75005 Paris, France
4 Musée du Louvre, Département des objets d’art, quai F. Mitterrand, 75001 Paris, France
5 XGLab S.R.L. – Brucker, 23 Via Conte Rossolo, 20134 Milan, Italy
6 Château de Fontainebleau, 77300 Fontainebleau, France

Background and Scope of the Study

Both Chinese and European historical records report that French Ambassador of Louis XIV and the Jesuit missionaries were hosted at the Kangxi Court during the 17th century, and they presented outstanding enamelled artesfacts as gifts to the Chinese emperor. Among these presents were enamelled metal objects which offer a complex realistic painted decor of enamels. It is also known that according to the demand of Kangxi Emperor, this advanced enamelling technology was taught to Chinese craftsmen at the workshops inside the Beijing Forbidden Palace. Royal archives mention that pigments and ingredients required to make such enamels were imported from Europe and this trade was regularly followed [1-2].

In this study, we present the non-invasive on-site study of 10 enamelled metal wares dating to the 17th-century Qing Dynasty from the collections of Musée du Louvre and Château de Fontainebleau (Musée Chinois) by non-invasive mobile Raman microspectroscopy and portable X-ray fluorescence spectroscopy. These metal wares were produced by cloisonné and painted enamel techniques. The objective of the study is to compare the enamelling technology used in these artefacts, regarding the different types of enamels with the identification of pigments/opacifiers and glass compositions used [3].

The study is expected to provide arguments to identify the use of imported enamels and/or enamel recipes from Europe to China at the end of the 17th century under the guidance of Jesuits as reported in the Historical records.

Analytical Techniques

- Mobile Raman set up (HORIBA Jobin-Yvon, Longjumeau France)
- 532-nm Vertix 300-nm laser (Laser Quantum) and 400 (NIKON) and x200 (Miltonyi Corp) | long working distance objectives
- Portable Elto XRF instrument (XGLab Bruker, Italy)
- 40 kV tube voltage, 150 mA current, 480 aquisition time

Results-Discussion

The Kangxi tripod with cloisonné (C) enamels:

- Glassy Si-O Matrix
- Variations of lead-enamel type of glass: a) the strongest component at ~1030 to 1059 cm⁻¹, b) rather similar intensity of ~975 and 1045 cm⁻¹ components, c) the strongest component at ~1065–1070 cm⁻¹, d) the strongest component at ~1080–1100 cm⁻¹
- Pigments and Opacifiers
- White: Fluorite (320 cm⁻¹)
- Blue: Co³⁺ ions
- Yellow: Pb-Sn pyrochlore (~135,320,435 cm⁻¹)
- Light green: Pb-Sb Sn/Zn pyrochlore (~135,231,377,470 cm⁻¹)
- Cassiterite (831, 780 cm⁻¹) + Co³⁺ ions
- Red: Cu²⁺ nanoparticles (fluorescence)

The Kangxi tripod mostly displays the characteristics of Chinese technology with fluorite opacification and copper red. Only the yellow and green enamels are made with European ingredients/techniques.

The Qianlong ewer with cloisonné (C) / painted (P) enamels:

- Glassy Si-O Matrix (C)
- Lead-enamel type of glass with the strongest component at ~1070 cm⁻¹
- Pigments and Opacifiers (C)
- Blue: Co³⁺ ions
- Yellow: Pb-Sn pyrochlore (~135,330,452 cm⁻¹)
- Green: Pb-Sn-Pb-Sb-Zn pyrochlore (~135,325,450,520 cm⁻¹) + Co³⁺ ions
- Pink: Au⁺ nanoparticles (fluorescence) + arsenate (815 cm⁻¹)
- Glassy Si-O Matrix (P)
- Lead-enamel type of glass with the strongest components at ~980 cm⁻¹ and 1046 cm⁻¹
- Pigments and Opacifiers (P)
- White: Lead arsenate (~820 cm⁻¹)
- Blue: Co³⁺ ions + lead arsenate (~820 cm⁻¹)
- Yellow: Pb-Sb pyrochlore (~130,340,455,506 cm⁻¹)
- Green: Pb-Sn-Pb-Sb-Zn pyrochlore (~135,325,450,516 cm⁻¹) + Co³⁺ ions + Cassiterite (832,775 cm⁻¹)
- Orange: Hematite (~225, 410,1318 cm⁻¹)

The Qianlong ewer represents the use of European ingredients/techniques with the lead pyrochlore pigment, gold nanoparticles and European cobalt rich (rich in Au).

Conclusion

This analytical study confirms the capability of on-site Raman analysis with mobile set-up for characterization of the sophisticated enamelled wares from China. The 17th–18th century turn marks the period of close contact between Europe and China through the Jesuits hosted at the Chinese Court. The results particularly contribute to identification of the artefacts where ingredients or recipes from Europe had been used for enamelling.

It is significant that cinnabarite was probably used as an opacifier in some of the metal wares. Lead arsenate detected in some of the 17th–18th century blue enamels is related to the use of arsenic-rich European cobalt ores.