ANALYSIS OF PIGMENTS AND STRUCTURAL MATERIALS ON ROMAN TERRACOTTA

APPLICATION NOTE RAMAN-015 (US)

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Abstract

This application note documents a pigment analysis on a decorative mirror plaque from late Roman times performed with a TSI ChemLogix EZRaman-NP.

Figure 1. Roman terracotta piece, likely an architectural mirror.

Sample Description

The spectral and ID data in this application note is based on Raman analysis of the pigments in a sample of Roman pottery, 100 to 300 AD, found in Jerusalem. It is in the collection of an anonymous private collector.

The terracotta disk has been decorated with a sun design and has a central circular hole that is partially occupied by a fragment of glass. It is unclear whether the odd shape of the glass is original or reflects a breakage or loss (presumably in antiquity).

The interior circle nearest the glass insert has a raised rim. Around the interior edge (over the glass), there is a layer of white material, possibly plaster. It is unclear whether this is original. Around the interior circle are molded triangles with dots at the peaks that create a sunburst design. These are painted red and in between each are a black dot and a red stripe. The outside edge is slightly irregular as is the essentially flat back. The back has fingerprints from the artist who pressed the clay into a mold to create the front. There is one small hole that originally went through the piece near one of the black painted dots. It is now blocked with clay.

Figure 2. Measurements on the mirror with TSI ChemLogix EZRaman-NP.

Most personal mirrors of this period are made of bronze or lead and the majority of them have a handle, unlike our artifact. The item is likely, then, not a personal mirror but possibly an architectural one. There is good evidence of the apotropaic (protective) use of architectural mirrors in the early Christian era. Some have been discovered embedded in catacombs. Scholars have argued that the concentric circles that appear on many everyday items like lamps, etc. should be interpreted as apotropaic devices to ward off the evil eye. This idea was present in the pagan Roman era as well, but takes on this interesting aniconic form in the Late Roman/early Christian era. Lastly, mirrors are a historically traditional strategy to divert the evil eye or cause the effect of the evil eye to "fall back upon itself in some sort of auto-fascination."[1]

Measurements and Results

A TSI ChemLogix EZRaman-NP portable Raman spectrometer with a 785 nm excitation laser and a spectral range of 250-2350 cm^{-1} was used to acquire data on the pigments. Because of the fragility and value of the artifact, very low excitation power was used (15 mW). Because of the low laser power, the acquisition times were commensurately longer than in other analyses. The instrument probe was held at the optimal working distance from the piece with an XYZ precision stage. Room light was excluded with a piece of black laser curtain material. During the testing, the output of the system was checked three times with a power meter, and was found to be stable, even at this low level. Spectral matching was performed with the SpectraGryph program.[2]

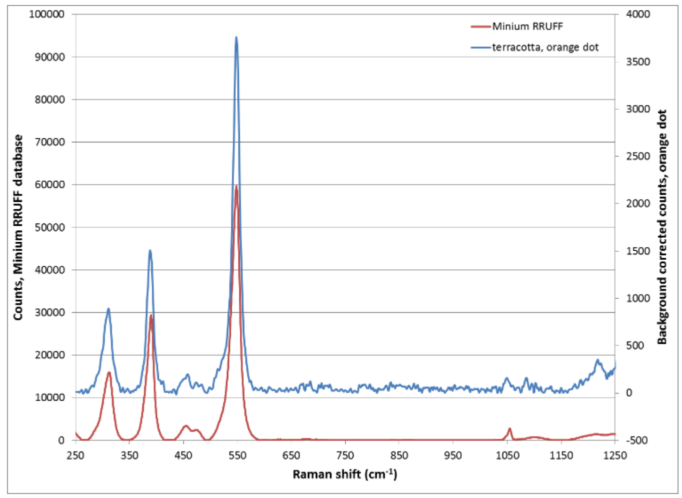

Figure 3. Spectrum of the orange dot on terracotta surface, superimposed with RRUFF minium spectrum.[3]

The first tested surface was one of the orange dots. The spectrum of this pigment has features at 310, 387 and 548 cm^{-1} that match the University of Arizona RRUFF database spectrum of the mineral minium well.[3]

Minium is the naturally occurring form of lead tetroxide, Pb_3O_4, also known as red lead. Minium is a light-to-vivid red color and may have brown-to-yellow tints. Minium is a pigment used since antiquity, named by the Romans for the Iberian river, Minius. The name was first applied to cinnabar that had been coated with lead oxide, but when the coating was determined to be chemically distinct from the bulk, the appellation "minium" was applied to the coating material.

The second measurement was performed on the white material around the embedded glass piece, initially thought to be plaster. This material shows a good match with the RRUFF calcite spectra, shown in Figure 4.[3] The white material can be seen to be at least mostly composed of calcite (chalk), even analyzed through the glass fixed inside it. Again, the presence of this material is historically reasonable, given the age and provenance of the item.

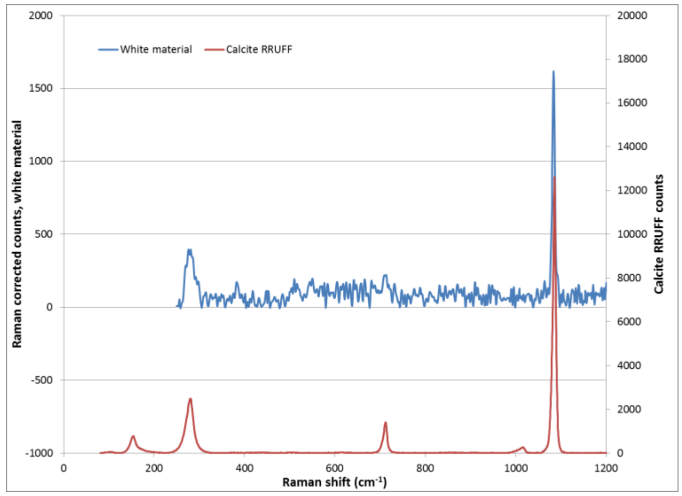

Figure 4. Spectrum of the white material on terracotta surface, superimposed with RRUFF calcite spectrum.[3]

Other regions of the item were also analyzed. The darker regions had very low signal returns, no doubt because of the low laser power used to make the analyses. The darker brown features (the dots and the triangles) seem to have features associated with lamp-black in them, and the triangular features also has features that can be easily matched to red ochre (iron oxide).

Summary

The pigments on a decorative mirror plaque from late Roman times was analyzed with a TSI ChemLogix EZRaman-NP with a 785 nm laser. Even though a very low laser power was used for these measurements because of the value and rarity of the item, sufficient signal was obtained on most of the surface features to identify the pigments, which were all historically reasonable, given the assigned age and origin of the piece. The owner of the plaque is excited to use the instrument to analyze more of their collection.

Acknowledgement

TSI Incorporated and Amy Bauer thank Drs. Vanessa Rousseau and David Peterson for arranging access to the artifact and discussing its origin and likely use. Dr. Rousseau is the president of the Minnesota Society of the Archaeological Institute of America, antiquities consultant for the Weisman Museum and visiting professor at Macalester College. Dr. Peterson is a researcher at CAMAS Laboratory, Idaho State University.

References

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