AiA Art News-service

Analysis of Artists Paints using FT-IR

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Visitors flock from around the world to view the priceless works of art that are on display in museums, and to ensure the pieces are kept in the best possible condition, conservators face many challenges. One of the trickiest questions is how to best care for these assets.

Before any conservation work can be done the materials used in the arts production must be identified. Once this is done recommendations can be made for display, care, restoration, or storage. Another concern to the museum is the whether the piece is real or not. Recent high-profile cases of organized forgery enterprises highlight this concern [1,2], and prove why determining the materials used is so crucial. With the materials identified, the piece can be dated and its provenance known.

Identification of historical materials on works of art is a complex task, due to the coatings on the piece usually comprising of a number of components. On top of this, these component materials have changed over time. Older paints consisted of ingredients that could be found in nature, unlike modern, synthetic acrylic-based paints.

FT-IR Microspectroscopy for Conservation and Authenticity Studies

Not being as stable as synthetic paints, many natural materials can degrade over time and cause the artwork to change in color. For example, Vincent Van Gogh had a preferred organic red pigment, red lake, that fades extremely quickly when

exposed to light. This can be seen in his famous painting “Roses,” with the once pink roses having faded to white.

Fourier Transform Infrared Spectroscopy (FT-IR) analyses the vibrations of the molecules in a material to provide a wealth of information regarding the materials molecular structure, and displays the results in a spectrum. A huge advantage for its use with paintings and artists materials is that FT-IR is a non-destructive technique and, when using microspectroscopy, very little sample is required to make an accurate identification.

In microspectroscopy there is a minimal quantity of sample required and therefore, the integrity of the work is not harmed. By its nature, FT-IR microspectroscopy is an enormous benefit to the analysis of complex, multi-component samples. In first selecting the target area with microscopical observation, these certain areas that can then be measured spectroscopically.

Czitek has just launched the SurveyIR, a brand new, compact FT-IR microspectroscopy accessory that can be mounted to any commercially available FTIR instrument. Any requirement for cryogenic cooling is removed as it uses the standard detector found in most instruments. SurveyIR also has a small footprint and simple installation procedure. This combination allows modern, small FT-IR instruments, to be deployed in situations where samples cannot be removed from the location of the artwork. SurveyIR also makes use of digital imaging software to observe, document, analyze, and store images.

Results and Discussion

The authenticity of a painting can be determined through the identity of the pigments used in its composition. Fig. 1 is a picture of two examples of paint chips taken from different works of art which, upon first reaction, appear to be almost similar in color and nearly indistinguishable.

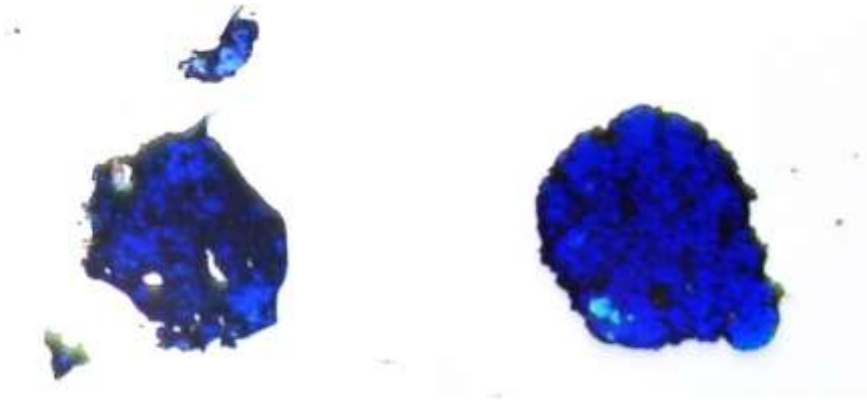

Figure 1. *(Left) Acrylic Prussian blue hue; (Right) Oil based Prussian blue.*

Both images are of the color Prussian blue, but it is their material composition which is what sets them apart. The left image in Fig. 1 is of an acrylic Prussian blue hue, developed in the late 1940's [3]. The right-hand image however, is a paint sample containing the previously used inorganic pigment Prussian blue, first synthesized in 1704 and commercially available by 1724. The binder in this pigment was oil based [4], in contrast to the polymers used in the synthetic paints used today. To the naked eye these paints are almost indistinguishable; however, the IR spectra in Fig 2 shows that they are vastly different in their chemical composition.

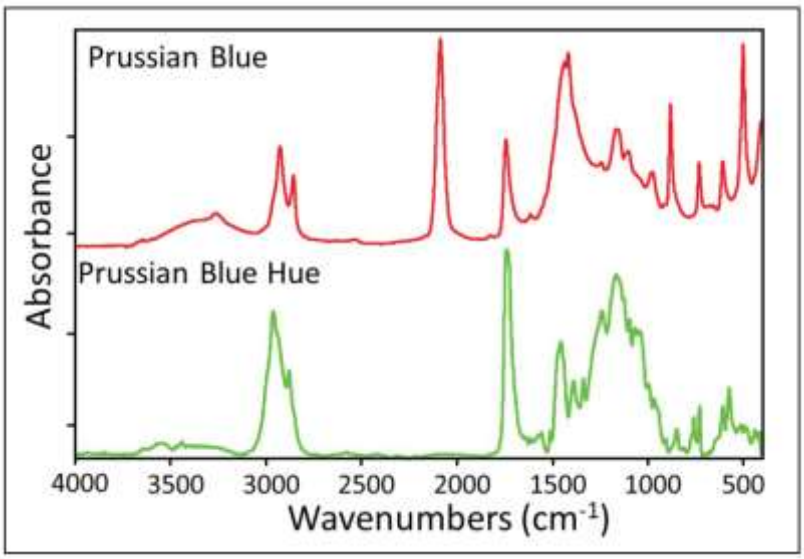

Figure 2. *IR spectra of oil based Prussian blue (Top, Red) and acrylic Prussian blue hue (Bottom, Green).*

As seen in Fig. 2, the difference that really sets the two paint chip spectra apart is the band at 2083 cm^{-1} in the spectrum of Prussian blue (Red). The band at 2083 cm^{-1} can be attributed to the C N stretch of the cyano groups in iron hexacyanoferrate

(Prussian blue). The green spectral line shows the Prussian blue hue, where it is the main acrylic component that dominates the spectrum from 1000-1300 cm^{-1}.

In comparison to the oil based paint, the actual pigment within the acrylic paint does not have as dominant features as there is a lesser amount present within the paint. With these features of the spectra and paint samples understood, collectors have the evidence to investigate claims of legitimacy by confirming the materials coincide with the artists' time period.

As well as being used to investigate claims of authenticity in older works of art, identifying all the components of the paint used can assist in the artworks preservation. As mentioned before it is common for older works of art to contain materials that may degrade under certain environmental conditions [5]. The following example concerns a yellow paint sample removed from a historical painting.

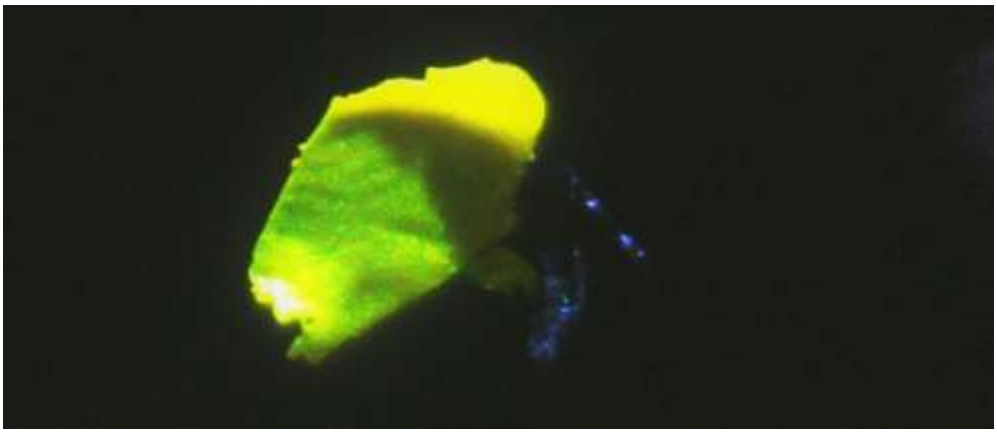

Figure 3. *Yellow paint chip imaged with oblique illumination.*

To prepare the sample, the specimen in Fig. 3 was flattened. It was then placed onto an IR transparent Potassium Bromide (KBr) window for analysis.

There were three components within the sample identified using FT-IR. Fig.4 (black) shows that the primary carrier for the paint pigment is linseed oil (red), an oil that has been used across history as the pigment vehicle in oil based paints. Once the linseed oil was spectrally compensated, the pigment itself could be identified by a spectral library search as Dalamar yellow (blue).

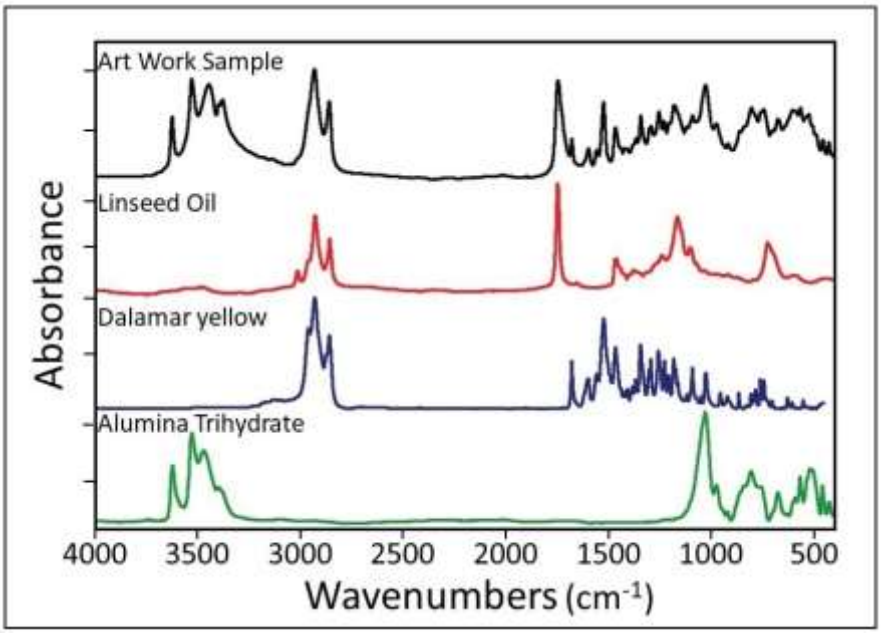

Figure 4. *(Right) IR spectra of the art work sample (top, black) and its complimentary components.*

The third and final component was confirmed as alumina trihydrate (green), a filler and extender that aids in bringing out the brilliant yellow color. In this case, the Dalamar yellow pigment is a resilient azo dye complex, making it more stable than most and thus not necessitating special environmental conditions, as opposed to other natural pigments such as red lake.

This is an excellent showcase of the power of FT-IR microspectroscopy in analyzing complex compositions. All three molecular constituents could be identified from a microscopic paint chip, with less than one (1) microgram of material.

Conclusion

There is a rising trend in the conservation and authenticity of works of art to in determining their detailed chemical composition. FT-IR microspectroscopy provides a powerful tool for conservators and forensic scientists to analyze an identify complex compositions of materials in artworks.

As well as minimizing damage risk from transport or theft, it also provides a workaround to the several international conventions that prevent artwork and antiquities from being relocated. The unique SurveyIR microscope accessory can facilitate identification at the location of the work.

References

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