Application Note AN # 77

# Contactless analysis of mural paintings with a new portable FT-IR analyzer

FT-IR spectroscopy is a widespread and powerful tool for the identification and characterization of a diverse range of materials. Molecular structures and components are identified via their typical infrared absorption bands. FT-IR spectroscopy can be applied for the qualitative characterization of materials, as well as for their quantification. In recent years, FT-IR spectroscopy has increasingly been employed to analyze the surfaces of materials and objects before their restoration, providing valuable information for choosing the best restoration method.

Until now, the application of FT-IR spectroscopy was restricted to the laboratory, as it was not possible to analyze the artwork on-site. Samples of frescos or mural paintings had to be taken off-site and subsequently shipped to a laboratory for analysis. The traditional FT-IR analysis of artwork in the lab is therefore destructive and time-consuming. Furthermore, it is causing additional costs (e.g. transportation and time) and the number of samples that can be taken for analysis is limited. Until now the potential of FT-IR spectroscopy for the restoration of artwork has not been fully exploited.

With Bruker's new portable ALPHA FT-IR spectrometer, on-site analysis of frescos and wall paintings in a contactless and non-destructive manner is now possible.

## Surface analysis of mural paintings by Francesco Albani in Bologna, Italy (End of XVI century)

The ALPHA FT-IR spectrometer proved its high potential during the restoration of mural paintings by Francesco Albani in Bologna, Italy (Figure 1 and 3). Selected areas of the mural paintings were analyzed before and after cleaning in order to decide on the best cleaning method and solvent or if the treatment is really effective. The spectra collected directly on the surface of the mural painting were compared to reference spectra from the library.

Figure 1: Mural painting by Francesco Albani in Bologna, Italy, during restoration process [1].

The ALPHA only takes up a 22cm by 30cm space, weighs about 7kg and can therefore easily be carried in a backpack.

Figure 2: The ALPHA, equipped with a dedicated reflection module, is placed in front of the mural painting to perform the FT-IR measurements.

As the ALPHA is insensitive to vibration, it can be placed almost anywhere, can be moved, and is immediately operational without any need for alignment. Equipped with a front-reflection module, which is designed for contactless and non-destructive FT-IR measurements, the portable ALPHA was placed in front of the mural painting (Figure 2). The ALPHA can also be placed on a tripod, the measurement position can be adjusted accordingly (Figure 8). In addition, the ALPHA's battery and wireless options enable extra portability features.


Figure 3: Detail of the mural painting during restoration process. Area 1: after cleaning; area 2: before cleaning.

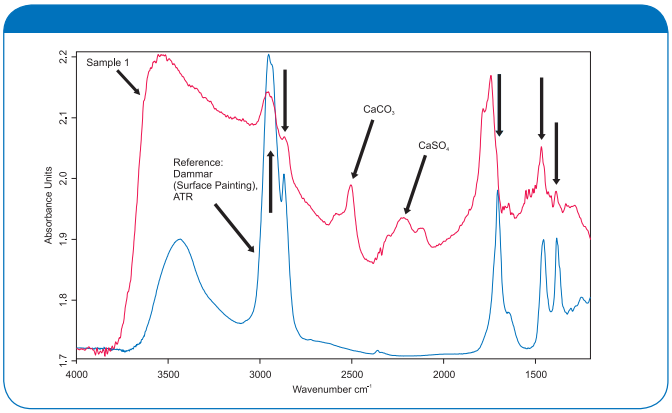



Figure 4: Spectrum of an area of the mural painting before cleaning showing typical absorbance of a terpenic varnish, calcium carbonate $CaCO_3$ and calcium sulfate $CaSO_4$.

First, a spectrum of the mural painting before restoration was taken (Figure 4) and compared with a reference spectrum of a terpenic varnish (for example, dammar). Typical absorbance bands for terpenic varnish, calcium carbonate and calcium sulfate were identified. Subsequently, the same area of mural painting was treated with acetone and a new spectrum after treatment was taken to control the cleaning effectiveness. As seen on Figure 5, the terpenic varnish has been completely removed by the acetone treatment; the typical bands of varnish are missing in the spectra.

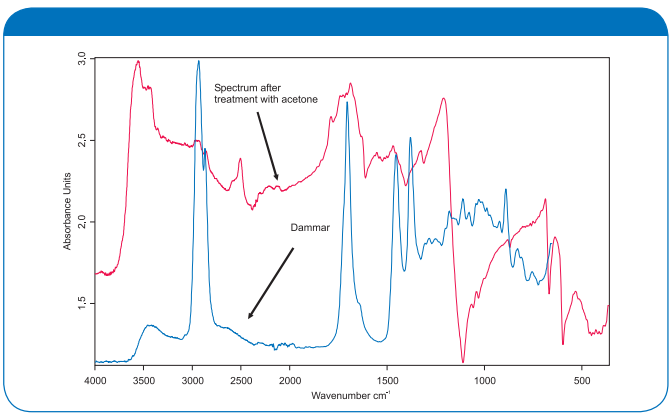



Figure 5: Spectrum (red) of the mural painting after treatment with acetone. The typical absorption bands of terpenic varnish (blue) are missing showing a successful treatment of the mural painting.

In addition, comparing the spectra of the treated mural painting with a spectrum reference for calcium sulfate (gypsum) from the library identifies the calcium sulfate and calcium carbonate (Figure 6).

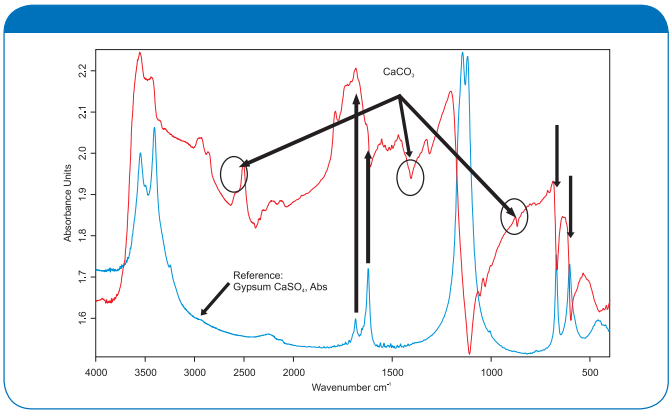



Figure 6: Spectrum (red) of the mural painting after treatment with acetone and comparison with a calcium sulfate reference (blue). Calcium sulfate and calcium carbonate are identified.

Subsequently, one part of the mural painting was treated with ammonium carbonate to remove the calcium sulfate. Figure 7 shows the successful treatment on the mural painting surface by the ammonium carbonate treatment; no absorbance peaks of calcium sulfate can be identified after this treatment step.

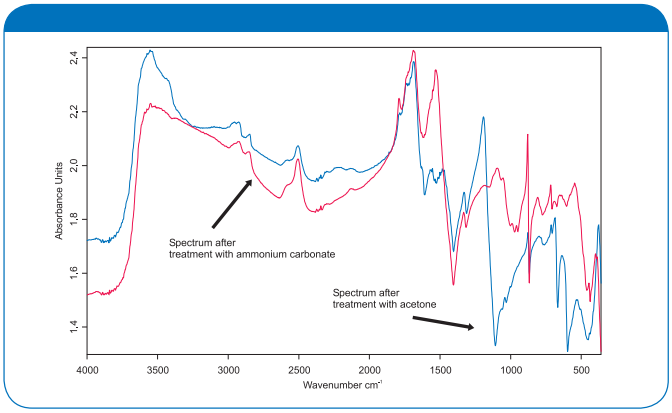



Figure 7: Spectrum of the mural painting after treatment with ammonium carbonate (red). Calcium sulfate was removed successfully. For comparison, the spectrum after treatment with acetone is displayed (blue).

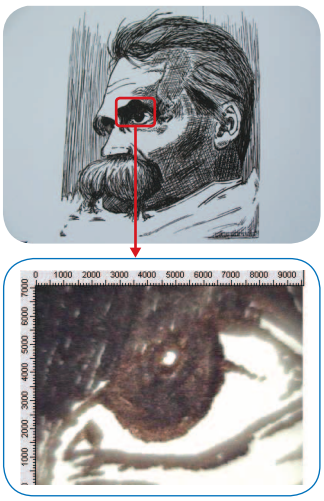
Consequently, it was possible to analyze the mural painting with the ALPHA before and after different surface treatments and to verify whether the treatments during the restoration procedure have been effective.

## Conclusion

The new portable ALPHA FT-IR spectrometer with reflection module is a flexible, easy to set up instrument that can be successfully utilized for the identification of materials on site and is therefore a powerful tool that can support conservators for the contactless analysis of frescos and mural paintings and assists in the subsequent restoration of the artwork.

Figure 8: The ALPHA FT-IR spectrometer with the tripod option at "Pinacoteca Nazionale di Bologna" during material screening.

## Integrated Video Camera



The integrated video camera allows exact positioning of sampling point. The figure on the top shows a photo of a lithograph and the figure on the bottom shows the life video image of the integrated video camera.

References:
Measurements performed in cooperation with Dr. D. Cauzzi, "Ministry of cultural Heritage, Soprintendenza BSAE" Bologna, Italy.

[1] A. Aldrovandi, F. Bandini, D. Cauzzi, P. I. Mariotti, A. Migliori
Indagini conoscitive e primi interventi conservativi sulle pitture murali dei Carracci in Palazzo Fava a Bologna OPD Restauro n.19
http://www.opificiodellepietredure.it/index.php?it/341/opd-restauro-n-19
http://www.opificiodellepietredure.it/index.php?it/298/le-pitture-murali-dei-carracci-a-bologna

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