

	<b>CONSTGLASS</b>	
	Technical Data sheet	

<b>Technique :</b>	<b>Vibrational infrared spectroscopy</b> FTIR / Raman
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### FTIR: Fourier transform infrared spectroscopy<sup>1</sup>

#### FTIR: Fourier transform infrared spectroscopy

IR spectroscopy is an analyzing technique, which uses the absorption of infrared radiation. The technique is often used in organic and inorganic chemistry to analyze the molecule structure or to identify materials by comparing the spectrum with a data base of known products. The samples under investigation can be solid, liquid or gasiform.

When the infrared radiation passes the sample the molecules absorb energy by vibration or rotation. The absorbed energy is characteristic for each molecule bonding condition and gives a peak in the spectrum. By interpreting the spectrum it is possible to draw conclusions about the molecule composition.

The FTIR spectroscope is a stationary system, installed in a laboratory. With systems with an extension arm objects can be analyzed in the laboratory without taking samples, see figure 1.

Different measuring methods are able with FTIR. Each method has its advantage and disadvantage:

- transmission
- reflexion
- attenuated total reflectance (ATR)

The transmission method is suitable for transparent materials, the reflexion mode for dull or colored materials. With ATR methods almost no sample preparation is necessary.

Analyzes by help of FTIR is e.g. suitable for the identification of organic coatings or bonding materials used for the consolidation of stained glass windows. The surface of the sample has to be almost even for optimum measuring results. The spectrum is compared with a data base with reference materials. Especially by analyzes of uncommon and weathered materials an identification is not possible in every case. Measuring of reference material (none weathered) is recommended.



Figure 1: FTIR spectroscopy with extension arm equipment.

<sup>1</sup> Only basic explanations of the techniques can be given here. For more detailed information consult further readings on infrared spectroscopy.



## Raman spectroscopy<sup>2</sup>

(Named after the Indian researcher Raman who discovered the Raman scattering.)

Raman spectroscopy bases also on the interaction between light and material. Molecules perform in correlation to the chemical composition and configuration defined vibrations with a characteristic frequency. If light with a certain frequency hit the sample then there will be an interaction with the vibrating or rotating molecules. Most of the light will be scattered elastic and leave the sample unchanged. Small part of the sample will be scattered elastic and change the wavelength (Raman scattering). The scattered wavelength is either higher or lower than the one original one<sup>3</sup>.



Figure 2:  $\mu$ -Raman spectroscopy.

Raman spectroscopy is a good tool to analyze non- and low polar bonding, like  $C\equiv C$ ,  $C=C$ ,  $N=N$ ,  $C-C$ ,  $O-O$ ,  $S-S$ , circular bonding, metal-metal bonding and others<sup>4</sup>.

The Raman spectroscopy can either be installed stationary in a laboratory, but also mobile systems for in situ analyses are available. Standard Raman systems can only analyze bulk materials. With confocal  $\mu$ -Raman microscopy (see figure 2) also very thin layers (e.g. coatings) and the substrate underneath can be identified without sampling - the laser is focused in the area of interest.

The excitation in a Raman spectroscopy is made by a distinct laser source. Depending on the used system different kinds of lasers are available, e.g.  $\lambda_0 = 488 \text{ nm}$  ( $Ar^+$ ),  $514 \text{ nm}$  ( $Ar^+$ ),  $633 \text{ nm}$  (He-Ne) or  $785 \text{ nm}$  (Diode).

FTIR and Raman are two complementary systems, e.g.  $H_2O$  has, because of his symmetry, a very low Raman spectrum, but can be detected very easy with FTIR. The FTIR and Raman spectra of the bonding material Epidian can be seen in the following example.

<sup>2</sup> Only basic explanations of the techniques can be given here. For more detailed information consult further readings on infrared spectroscopy.

<sup>3</sup> Schüssler, U. et al *Raman-Mikrospektroskopie* in Wagner, G.A. *Einführung in die Archäometrie*, Springer, Berlin, 2007, p. 200f.

<sup>4</sup> Brehm, I *Raman-Spektroskopie* in *Thieme RÖMPP Online*, ver. 3.7, Georg Thieme Verlag, 2010



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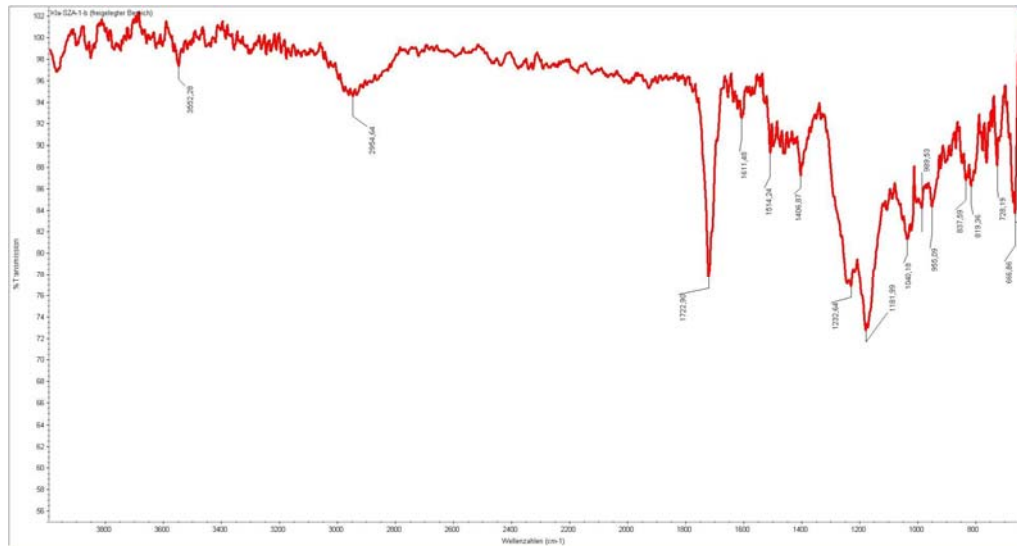


Example: IR spectra of Epidian®

FTIR spectra (measured with ATR)

x-axes: wave number from 4000 to 700 cm<sup>-1</sup>

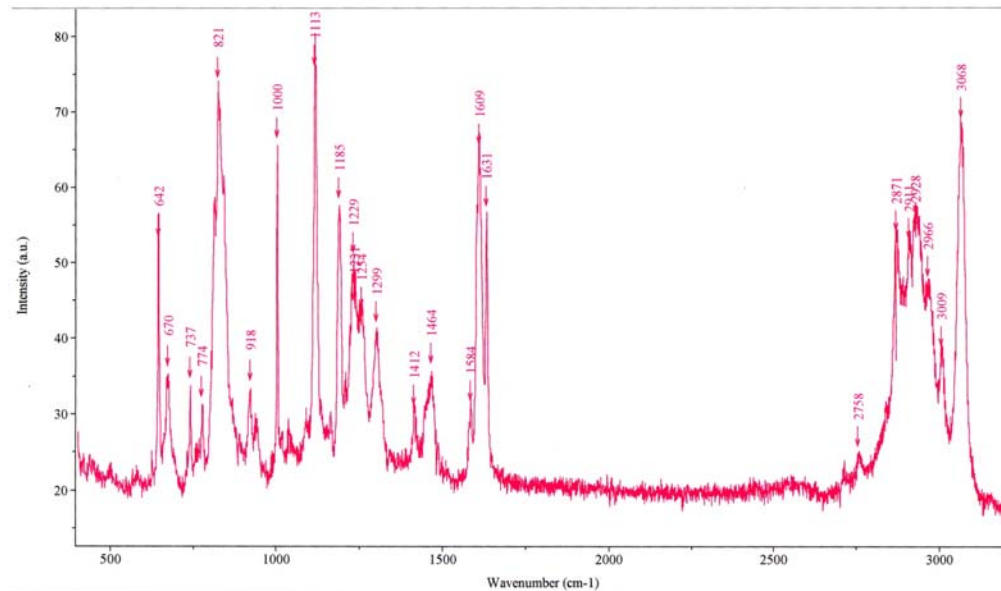
y-axes: % Transmission



μ-Raman spectra

x-axes: wave number from 450 to 3250 cm<sup>-1</sup>

y-axes: Intensity



Sample	: Reference (no. 217)	Excitation line	: 632.81	Filter	: ---
Date	: 11-05-2010 12:01	Grating	: 1800	Objectiv	: x100
Accumulation	: 20	Spectrograph	: 828.98	Remark	: zwischen Blasen
Time	: 2	Slit	: 100	File	: AFA_epidian_ref_1_peaks
Power	: 8.8 mW	Hole	: 200	Conditions	: Oberfläche