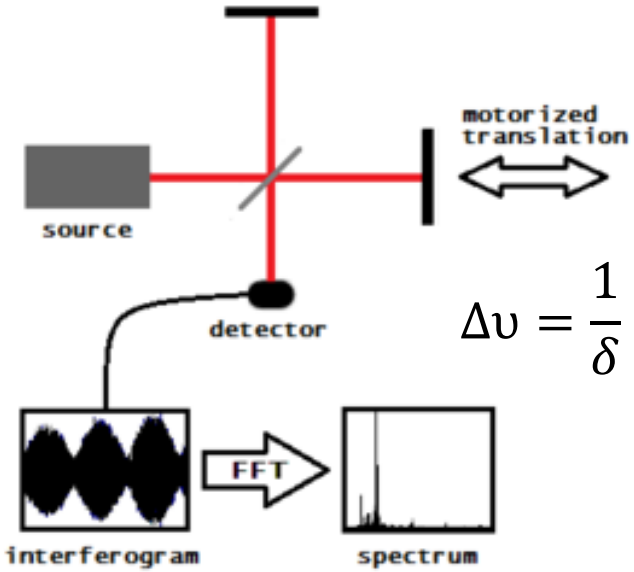
Principles of FTIR Spectroscopy

▪ In FTIR analyses, Infrared light from the light source passes through a Michelson interferometer along the optical path.

The Michelson interferometer comprises a beam splitter, moving mirror, and fixed mirror. The light beam split into two by the beam splitter is reflected from the moving mirror and fixed mirror, before being recombined by the beam splitter.

▪As the moving mirror makes reciprocating movements, the optical path difference to the fixed mirror changes, such that the phase difference changes with time. The light beams are recombined in the Michelson interferometer to produce interference light.



$$\Delta\upsilon = \frac{1}{\delta}$$

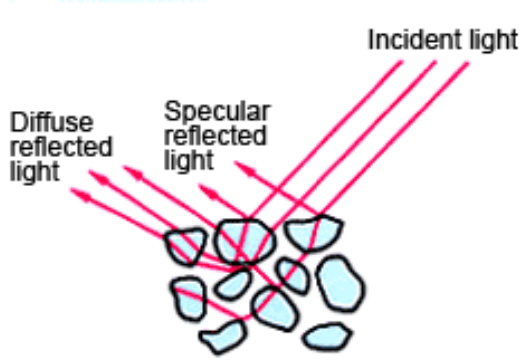
▪The intensity of the interference light is recorded in an interferogram, with the optical path difference recorded along the horizontal axis.

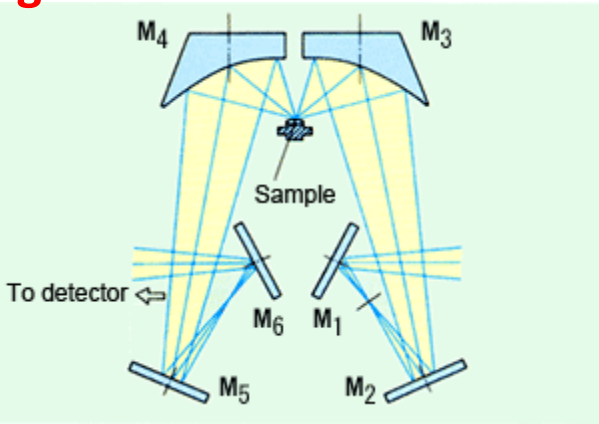
$f = \frac{2v_m}{c}\upsilon$ interferogram frequency

$v_m = \frac{\delta}{2t}$ mirror velocity

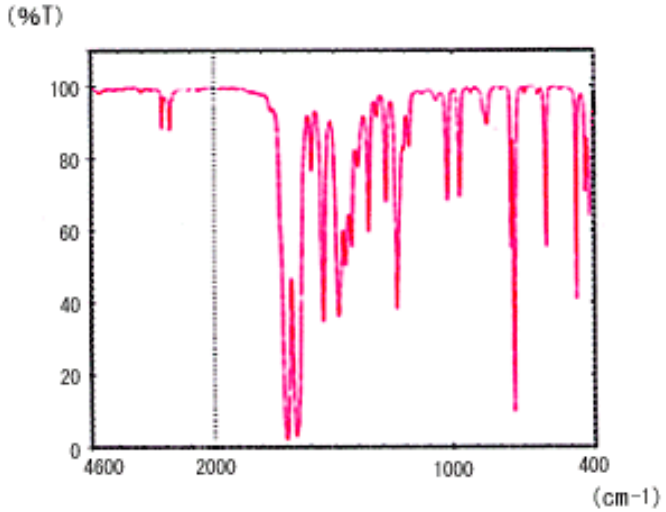
Principles of Diffuse Reflectance Method

Measurement of chemicals adhering to a surface - Powders



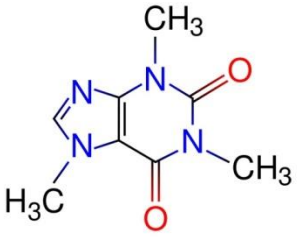


$$r_\infty = \frac{r_\infty(\text{Sample})}{r_\infty(\text{Standard powder})}$$ is measured, and $$f(r_\infty) = \frac{(1-r_\infty)^2}{2r_\infty} = \frac{K}{S}$$ is determined.



Spectrum of solid caffeine

K is the absorption coefficient, and S is the scattering coefficient. In practice, the comparative reflectance r_∞ with respect to a standard powder such as KBr or KCl, of which K is near zero (0) in the actual measurement range



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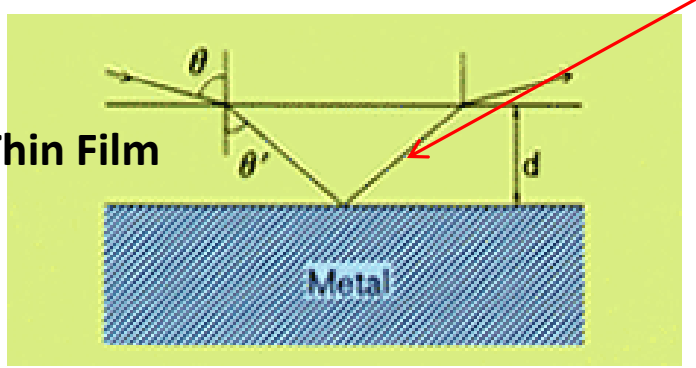
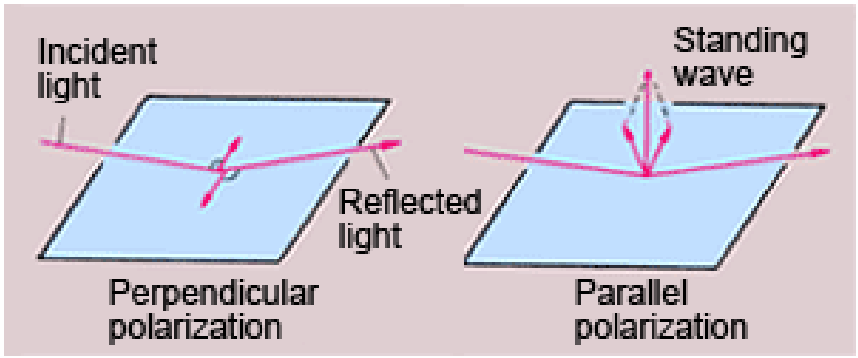
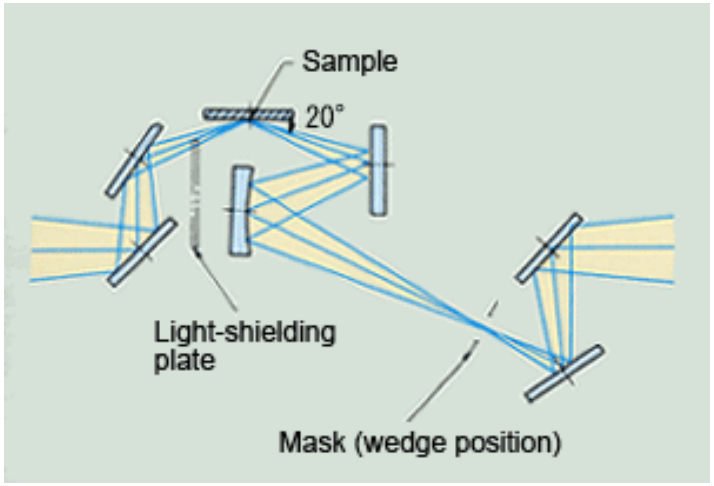
High Sensitivity Reflection Measurement

A reflection method is required to measure substances adhered to or applied to a material that does not permit light transmission, such as a metal sheet.





Only the parallel polarized light affects the absorption by the sample so using a polarizer for measurements increases the apparent peak size. Information on the sample orientation can also be acquired, as only functional groups with a perpendicular dipole moment with respect to the metal sheet are measured. However, such increases in sensitivity are available only with a metal substrate.



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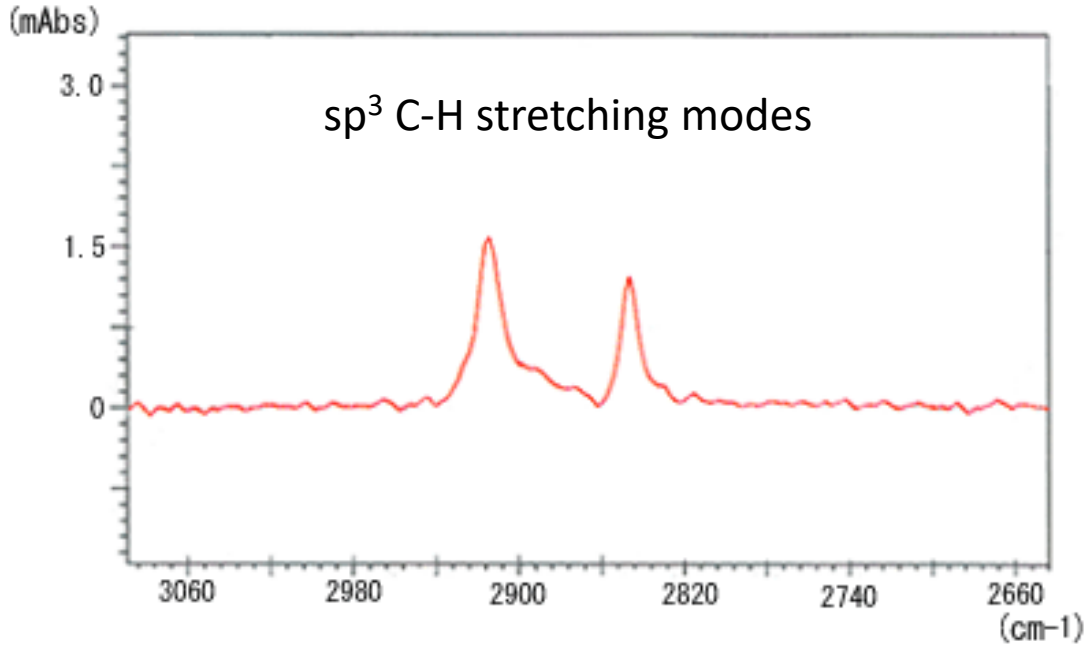

Spectrum of a 25 Å-thick organic film on a Au surface.

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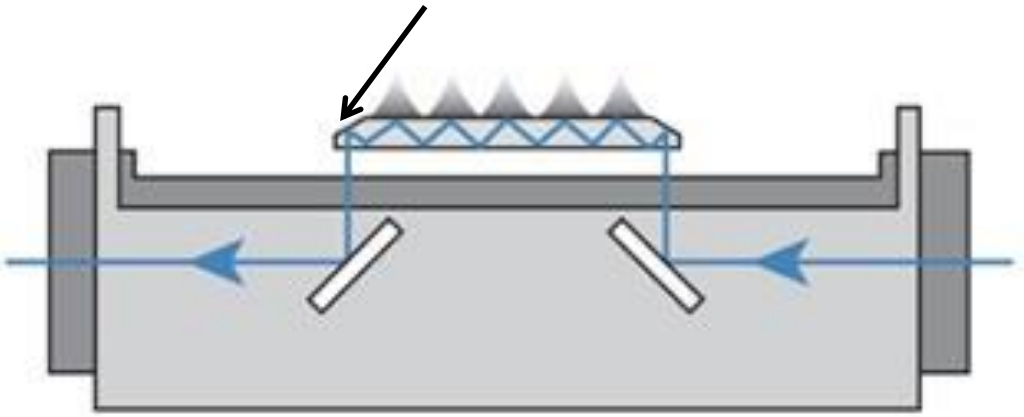
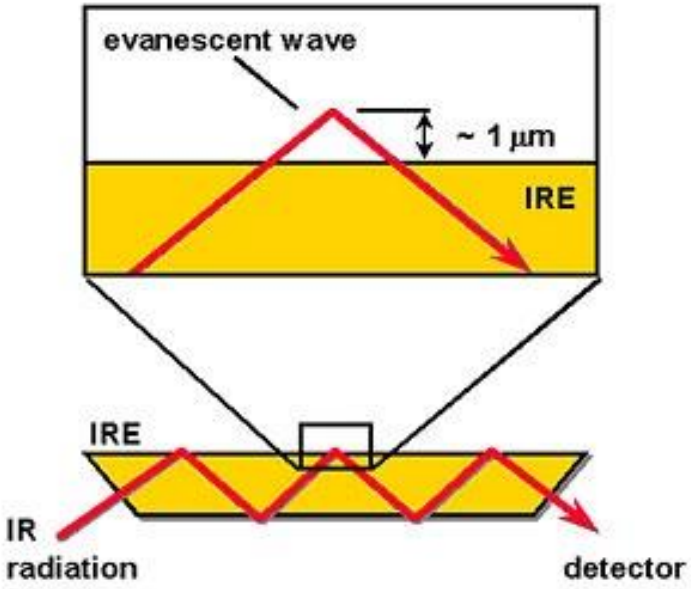
Attenuated Total Reflectance

Enables samples to be examined directly in the solid or liquid state without further preparation.

Diamond, Si, Ge (high refractive index)



Penetration depth = 0.5-2 μm



$$dp = \frac{\lambda_1}{2\pi\sqrt{\sin^2\theta - (n_2/n_1)^2}}$$

Where, θ is the angle of incidence of the infrared light; n_1,n_2 are the refractive indices of the prism and sample, respectively; and λ_1 is the wavelength in the prism ($\lambda_1 = \lambda\ n_1$, where λ is the wavelength in air).

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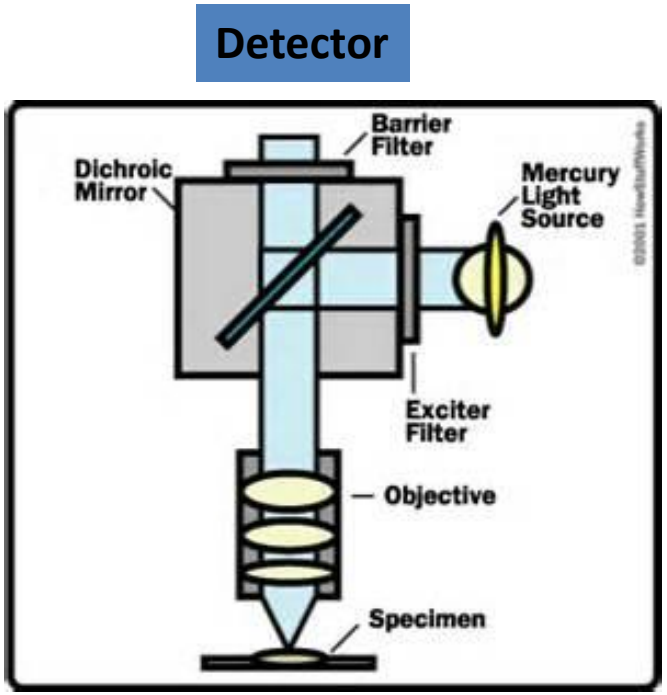
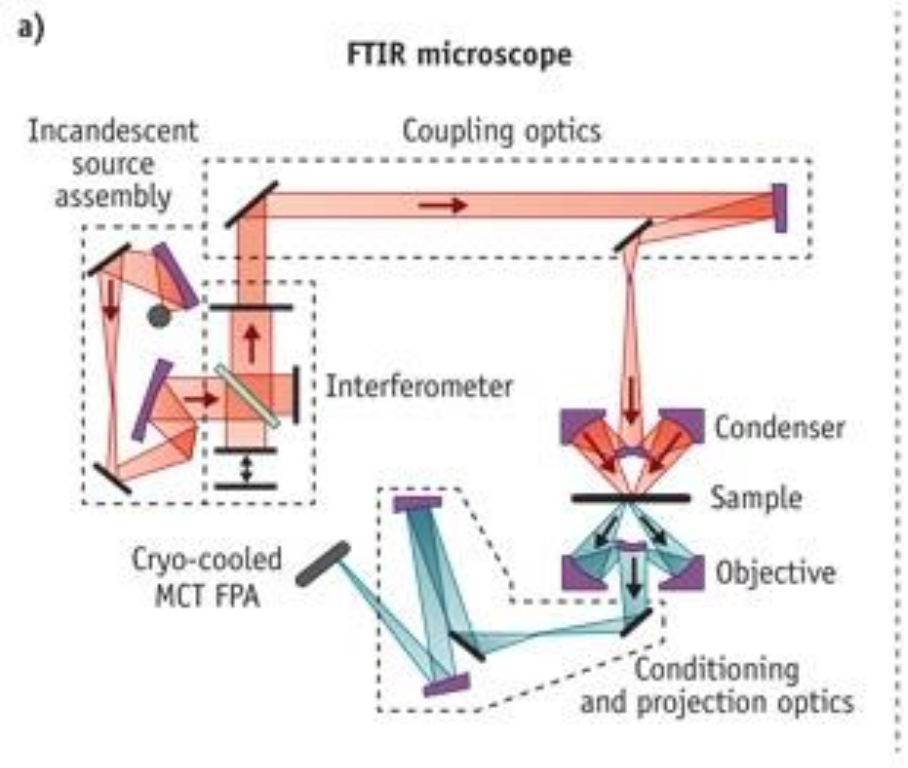
Fluorescence and FTIR Microscopy





Useful for generating spatial maps of "vibrational modes". For example, tissue analysis, polymer homogeneity, pharmaceutical quality, forensics.

Jasco website