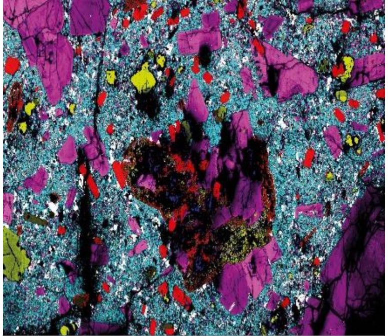
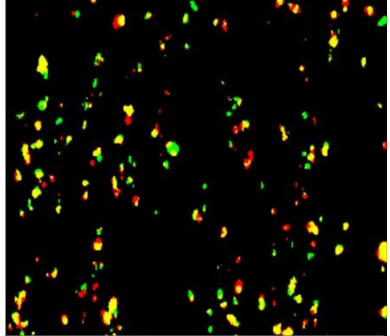
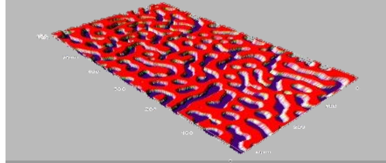
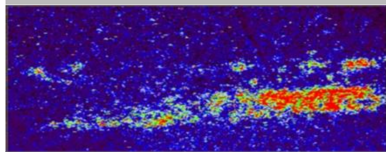

Volcanic rock section of Mount St. Helens


Active pharmaceutical ingredient particles


Surface plot of polymers


Discoloured polycrystalline solar cell

Micro-Raman Spectrometer

Surface Characterization Laboratory

Surface Characterization Laboratory

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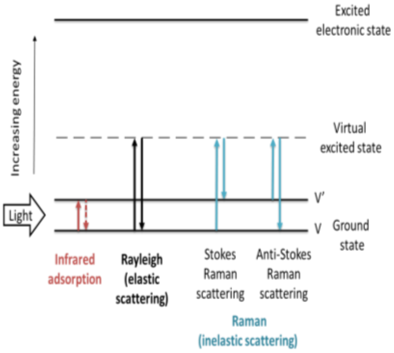


Adapted from Siebert, F. & Hildebrandt, P. Theory of Infrared Absorption and Raman Spectroscopy. Vibrational Spectroscopy in Life Science (2008)

The principle

Raman spectroscopy is a technique based on the inelastic scattering of monochromatic light, usually from a laser source, which provides chemical information. When light interacts with a sample, excites molecules, inducing oscillating dipoles and it is usually scattered without any change in energy, *elastic* or *Rayleigh scattering*. But 1 in a 10^6 reemitted photons, the frequency is shifted, known as *inelastic* or *Raman scattering*. The shift in frequency can be a consequence of part of the photon's energy transferred to the Raman-active mode and the resulting frequency of scattered light is reduced – *Stokes scattering*. In other case, a photon is absorbed by a Raman-active molecule, which, is already in the excited vibrational state. Consequently, excessive energy of excited Raman-active mode is released, and the resulting frequency of scattered light increases – *Anti-Stokes scattering.*

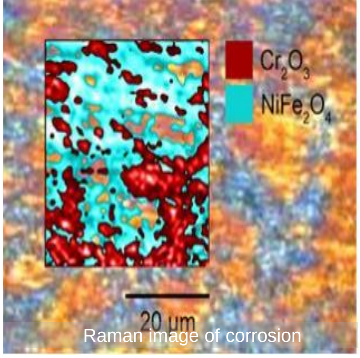
Because molecules vibrate at a particular set of frequency, this change provides information about vibrational, rotational and other low frequency transitions in molecules. Hence, is specific to the individual molecules giving a *fingerprint* Raman spectrum of the material.

Key features

- High optical efficiency
- High spectral resolution, stability and bandwidth
- Broad-range artefact-free spectra
- Low wavenumber performance
- Highly sensitive detectors
- Truly confocal performance
- High performance microscope
- Extended sample viewing
- Multiple lasers
- Generate high quality Raman images
- Fully automated

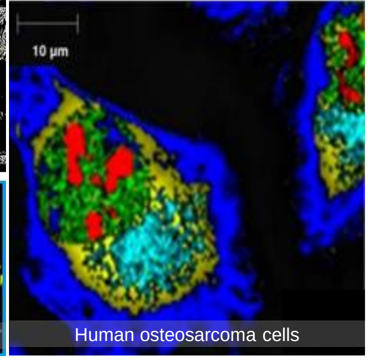
Applications

Micro-Raman spectrometers can be used in any application where non-destructive, microscopic, chemical analysis and/or imaging is required. It allows to rapidly characterize the chemical composition and structure of a sample, whether solid (particles, pellets, powers, films, fibers), liquid (gels, pastes) or gas. Little or no sample preparation is required and it is a label-free technique, which reduces the potential for artifacts. It is possible to analyze samples multiple times and to generate correlative and complementary information using downstream techniques.

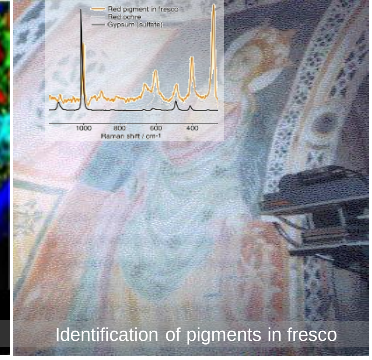


Raman image of corrosion

Dollar bill images with trace explosives



Human osteosarcoma cells


Identification of pigments in fresco

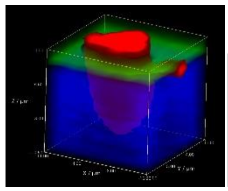
Technical specifications

inVia confocal Raman microscope

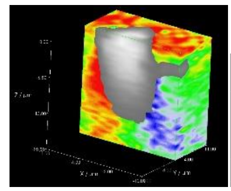
Lasers available	532 and 633 nm
Spectral resolution	0.3 cm^{-1} (FWHM)
Stability	<$\pm$0.01 cm^{-1}
Wavenumber cut-off	5 cm^{-1} – 30,000 cm^{-1}
Spatial resolution	0.25 μm (lateral) <1 μm (axial)
Detector size (standard)	1024 pixel × 256 pixel
Detector operation	Peltier based. No water or liquid nitrogen required
Depth (dual-laser systems)	930 mm

Characterization of semiconductors

Semiconductor materials are use in a wide range of applications in modern electronics.



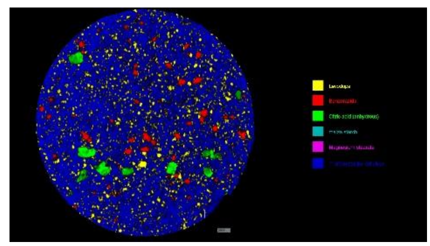
3D Raman image of 3C-SiC core inclusion, showing: 3C-SiC inclusion (red); 4H-SiC epilayer (green); 4H-SiC substrate (blue).



Stress regions surrounding the defect (grey) and 4H/3C boundary. Compressive stresses (red), tensile stresses (blue)

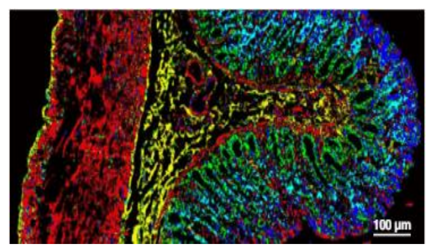
Pharmaceuticals and Cosmetics

Analyze over the entire sample surface obtaining representative chemical images.
StreamLine Raman image of tablet used for the treatment of Parkinson's disease.



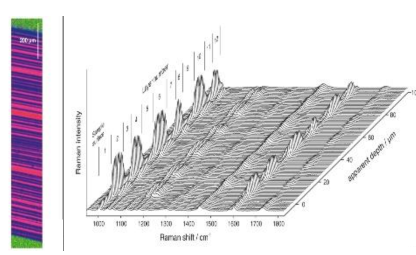
Understand biological systems…

Raman spectroscopy in life science allows for **label-free specific detection**. For instance, full spectrum of chemical information from entities such as nucleic acids, proteins and lipids, without the need for targeting biomolecules, markers, stains or dyes



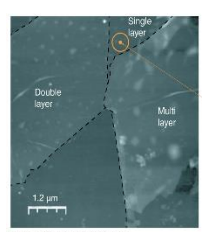
Determination of layer thicknesses with accuracy

To determine the composition and thicknesses of transparent polymer laminates it is necessary in-depth resolution and accurate sample positioning in all three dimensions for a successful analysis.

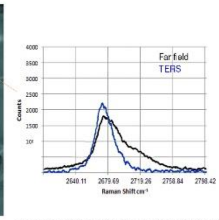


Combine Raman analysis with scanning probe microscopes

AFM image of a graphene flake with Raman spectra from far-field and tip-enhanced Raman Spectroscopy measurements. The carbon 2D band of the far-field spectrum (black) exhibits features of single-, double-, and multi-layer graphene. The band in the TERS spectrum (blue) is narrower than that of the far-field spectrum, and represents solely single-layer graphene.



AFM image of a graphene flake



Raman spectra from far field and TERS measurements