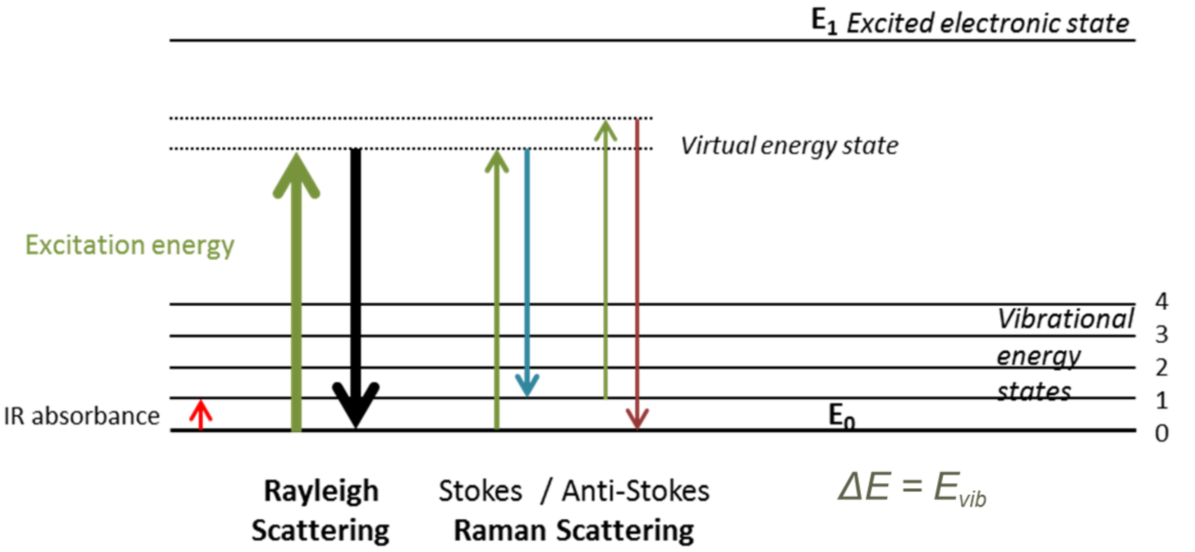
Raman spectroscopy



Raman spectroscopy is a vibrational technique based on the inelastic scattering of monochromatic light (laser). The difference in energy (or wavelength) of the scattered light from a material is characteristic for a particular bond in its molecular structure. The various energy shifts associated with different molecular vibrations leads to a Raman spectrum which is unique for each molecule and provides a precise spectral fingerprint.

Raman spectroscopy is an important analytical and research tool in different domains.

Instrumentation @ SURF:

- LabRAM HR Evolution (HORIBA Scientific) **NEW!**

The LabRAM HR Evolution is a fully integrated confocal Raman microscope equipped with a high stability confocal microscope with XYZ motorized stage, objectives 10x, 50x, 100x – 50x (WD=10.6mm) and a multichannel air cooled CCD detector (spectral resolution <1cm-1, lateral resolution 0.5µm, axial resolution 2µm). This instrument offers advanced techniques for mapping and imaging the samples. Two lasers are mounted on the instrument: a HeNe laser (633nm) and a Solid state laser (532nm).

- Dilor XY Raman spectroscope (HORIBA / Jobin Yvon) + Olympus BH2 microscope (objectives 50x (long distance: 8mm) – 100x) + liquid nitrogen cooled CCD detector (resolution ~ 2 cm^{-1}) and Coherent Innova 70C Ar/Kr mixed gas laser (514 nm & 647 nm): 1-100 mW.

Sample requisites:

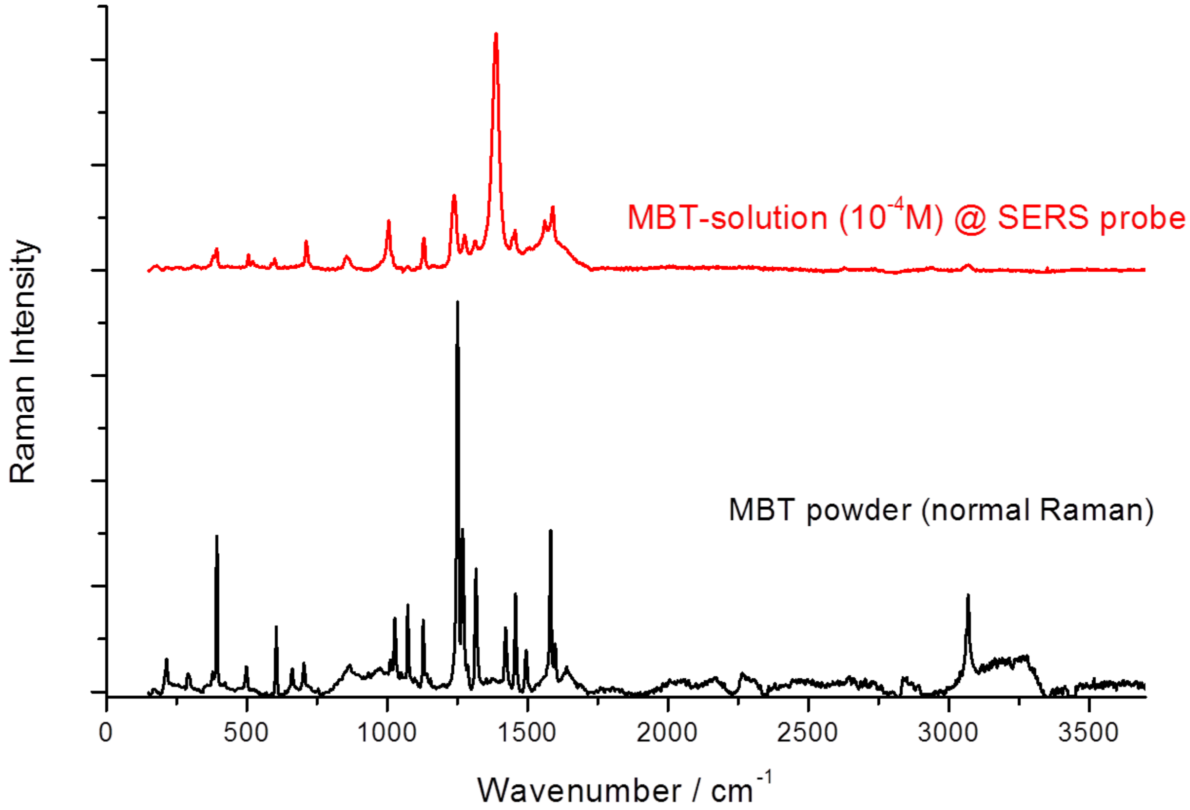
- there are no special sample requirements, which is an important advantage of Raman spectroscopy;
- no sample preparation;
- both small and large samples can be analysed;
- no ultra-high vacuum;
- glass and water are transparent for visible light.

The latter two points mean that some phenomena can be analysed in-situ with Raman spectroscopy.

Examples of previous or on-going case studies:

- art & archaeology: corrosion study of copper alloy artifacts, screening method for archaeological and historical glass;
- carbon: C-nanotubes, diamond-like carbon (DLC-coating);
- corrosion and protection of metals;
- coatings;
- electrochemistry: in-situ measurement at electrode surface;
- ionic liquids;
- polymers;
- printing materials, photopolymers;
- photography, (photo-)thermography;
- surface enhanced Raman spectroscopy - SERS;
    - in Ag-colloid solutions, at developed SERS-probes, at Ag- & Cu-electrodes;
    - to study thin layers of a material adsorbed on a metal.

As an example, the normal Raman and the surface enhanced Raman spectra of 2-mercaptobenzothiazole (MBT) are shown in the figure below. It is clear that although the MBT concentration is very low (10^{-4} M), an intense spectrum can be recorded thanks to the SERS effect. Some peak shifts and also different peak ratios are observed between the 2 spectra due to the interaction of MBT with the SERS probe (Ag).


MBT-solution (10-4M) @ SERS probe
MBT powder (normal Raman)
Raman Intensity
Wavenumber / cm-1
0
500
1000
1500
2000
2500
3000
3500