Fourier Transform Infrared and Raman Spectroscopy Laboratory (KORL)

Vibrational spectroscopy has been widely used in academic field and industrial laboratories for many applications. Both Raman and Infrared spectroscopic methods are forms of vibrational spectroscopy that provide unique information for each chemical substance. In other words; they give information about types of chemical bonds found in a molecule/compound. **Two Fourier Transform Infrared Spectrometers, Fourier Transform Raman Spectrometer and Dispersive Raman Spectrometer** are available to determine the spectroscopic properties of materials in METU Central Laboratory.

BASIC PRINCIPLES

In spectroscopic methods, the interactions (i.e. diffusion, absorption, scattering, deflection) between electro-magnetic radiation and substance and the results of this interactions are examined according to analytical purposes.

Infrared (IR) Spectroscopy: It is based on the absorption of infrared light by the substance to be measured. This absorption excites molecular vibrations and rotations, which have frequencies that are the same as those within the infrared range of the electromagnetic spectrum. Each chemical bonds have characteristic vibrational frequencies. When the infrared radiation is sent, the molecule only absorb the light in their vibrational frequency and measuring the amount of absorption, the structure and the functional groups (-OH, -NH, -C=O etc.) in the substance can be determined.

Infrared light can only be absorbed by a molecule if the dipole moment of the specific grups of atoms changed during the vibration. (For example; homodiatomic molecules like N_2, O_2 give no FTIR spectrum, it can be taken for HCl molecule).

Raman Spectroscopy: While infrared spectroscopy depends on absorption of infrared light in a sample, Raman Spectroscopy deals with inelastic scattering of light in a molecule. Raman scattering occurs if the polarizability of the bond changes during the vibration. This means that IR-inactive vibrations are Raman active if the polarizability changes. Raman and IR spectra therefore complement each other.

EQUIPMENTS/APPLICATION FIELDS

Fourier Transform Infrared and Raman Spectrometers are precise determination methods for research subjects in a wide range of scientific areas such as chemistry, physics, biology, dentistry, and most branches of engineering.

In Central Laboratory, infrared spectroscopy analysis of the materials can be performed in solid, liquid and gaseous phases of samples in the wide range of 5 to 25,000 cm^{-1} with microscope, ATR and several accessories.

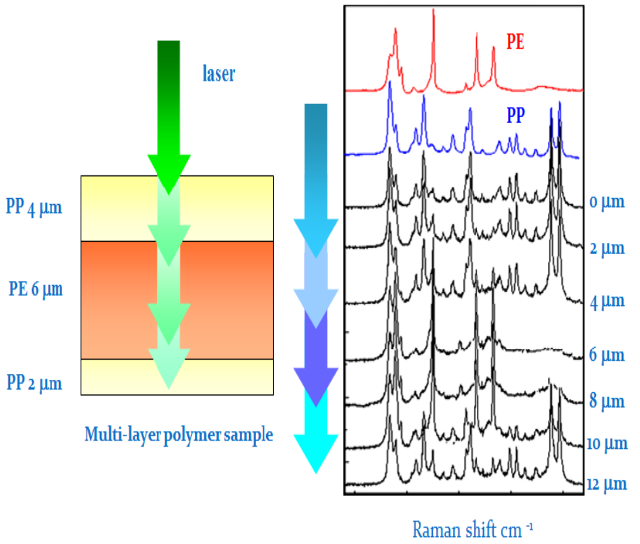
	Visible Region	**Infrared Region**		
Spectral Ranges	VIS	Near-IR (NIR)	Mid-IR (MIR)	Far-IR (FIR)
Wavenumber υ (cm^{-1})	25000 - 13000	13000 – 4000	4000 – 400	700 – 5

In Central Laboratory, Raman analysis can be performed with FT-Raman and Dispersive Raman. FT-Raman has one laser with 1064 nm, Dispersive Raman has 532, 633, 785 nm lasers. In Raman; organic, inorganic and biological samples can be analysed in both solid and liquid phases.

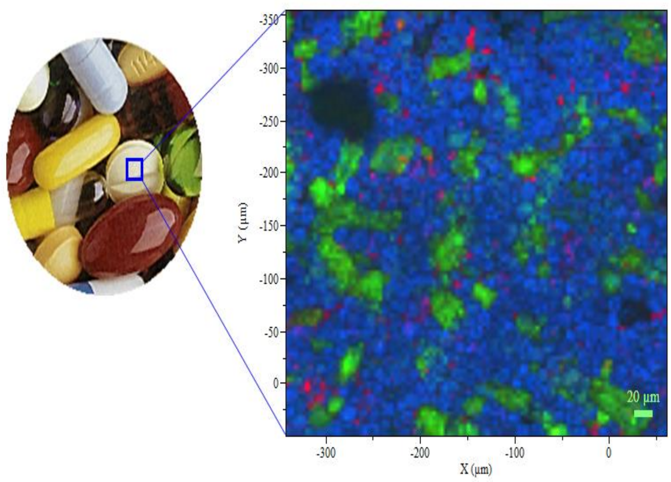
- Academics (Chemistry, Physics, Agriculture etc.)
- Food & Beverage Industries
- Forensics, Life Science
- Microanalysis
- Paper Industry
- Construction materials
- Polymers
- Process Analytical Technologies
- Process Control
- Recycling
- Surface Science
- Carbon nanotubes

CASE STUDIES

Multi-layer polymeric blends have been studied widely in industrial science in recent years. In addition to the surface of the polymer sequence analysis, layer thickness and transitions between the layers has gained importance in determining the usage of materials. A multilayer polymeric blend sample containing polypropylene and polyethylene analysis using the Dispersive Raman depth profiling and slicing method by using 532 nm laser is shown below. Polyethylene is represented by red and polypropylene by blue. Peaks were observed on the surface of polypropylene up to 4 µm depth while in between 4-10 µm there are peaks of polyethylene. In the final slice; polypropylene peaks were observed between 10-12 µm again. Different layers as shown in this example can be non-destructively analyzed at one time.



Dispersive Raman analysis of paracetamol tablet by using 785 nm laser with mapping method is shown below. Three materials present in the paracetamol (**Sugar**, **Cellulose** and **Magnesiumstearate**) are represented by different colors. By mapping method; materials present in the paracetamol mixture are examined non-destructively.



Accessories of FT-Infrared, FT-Raman and Dispersive Raman Spectrometers and Microscopes

FT-IR System	
IFS/66S	**FT-IR Microscope (Hyperion 1000)**
ZnSe and Diamond ATRs for solid and liquid samples	Grazing Angle Objective
Photo Acoustic Cell	
Heated Transmission Cell	Diamond ATR (20X)
Variable Temperature Cell	
High Temperature Pressure Chamber	Objectives • 15X • 36X
Low Voltage Heated Trans. Cell	
Specular Diffuse Option	Video Assisted Measurement Option
FT-Raman System	
FRA 106/S	**Raman Microscope (Ramanscope II)**
Sample Illumination module for 90^0 and 180^0	Objectives • 10X • 45X • 100X
Dispersive Raman System	
Renishaw/In Via	**Raman Microscope**
Depth Profilling and Slicing	Objectives • 5X • 20X • 50X • 100X
Mapping	
Polarization	
Sample Illumination module for 90^0 and 180^0	
Motorized Sample Positioning	
Cuvette for liquid samples	

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