The multilaser confocal Renishaw InVia Reflex Raman spectrometer coupled with the NT-MDT Ntegra Spectra SPM microscope (Raman-SPM system) has been achieved using funding from Romanian National Authority for Scientific Research, contract *Integrated Network For Interdisciplinary Researches* (INIR), Sectorial Operational Programme "Increase Of Economic Competitiveness" (PRIORITY AXIS 2– RD&I: Operation 2.2.1, National Programme “Capacities”).

The system was purchased and installed in December 2012 and allows cutting edge research in a wide variety of research fields, being automated for ease of use for both point analysis and mapping. It is located within the main building of the Babeş-Bolyai University – Laboratory of Applied Experimental and Theoretical Spectroscopy.

Due to its six laser exciting lines and to the Next filters that allows Raman measurements down to 10 cm^{-1}, the Raman spectrometer is unique in Romania and one of the most advanced in the central and Eastern Europe.

Capabilities:

Renishaw Raman spectrometer

- Six laser excitation sources covering the spectral range from UV to NIR: 325, 442, 532, 633, 785 and 830 nm

Producer – Type	λ(nm)	P(mW)	Obs.
Kimmon, Gas, He-Cd, air cooled, plasma filter	325	20	Edge filter: > 200 cm^{-1} PL: up to 1000 nm Working with: NUV 15x (NA 0.32, WD 8.5 mm) and 40x (NA 0.5, WD 1mm), grating 2400 lines/mm
Kimmon, Gas, He-Cd, air cooled, plasma filter	442	80	Edge filter: >200 cm^{-1} PL: up to 1000 nm Working with: NUV 15x (NA 0.32, WD 8.5 mm) and 40x (NA 0.5, WD 1mm), grating 2400 lines/mm
Cobolt, Diode Pumped Solid State (DPSS), air cooled, plasma filter	532	200	Edge filter: >100 cm^{-1} Next filter: >10 cm^{-1}
Gas, He-Ne, air cooled, plasma filter	633	17	Edge filter: >100 cm^{-1} Next filter: >10 cm^{-1}
Renishaw High Power NIR Diode, air cooled, plasma filter	785	300	Edge filter: >100 cm^{-1}
Renishaw High Power NIR Diode, air cooled, plasma filter	830	300	Edge filter: >100 cm^{-1}

- Focal length: 250 mm
- Spectral resolution: 0.5 cm^{-1} in visible and 1 cm^{-1} in NUV and IR
- Spatial resolution: < 1 μm (lateral), <2 μm (depth)
- Dispersion: <0.5 cm^{-1}/pixel

- Filters:
  4 Edge filters (< 100 cm^{-1} in Vis and NIR and <200 cm^{-1} in UV for all the six laser lines)
  2 Photoluminescence filters for 325 and 442 nm excitation lines
  2 Near-Excitation Tuneable (NExT) Filters for the 532 and 633 nm laser lines
- Difraction gratings: 600, 1200, 1800 and 2400 lines/mm
- Detectors: RenCam CCD detector, 1024x256 pixels (200-1060 nm) and InGAs (800-1660 nm)
- Optical microscope: Leica research grade (integrated, lateral confocal resolution < 1 μm, axial confocal resolution < 2μm)
- Set of optical objectives:
  - Vis/NIR: 5X (NA 0.12 WD 13.2 mm), 20X (NA 0.35, WD 20 mm), 50X (NA 0.75, WD 0.37 mm) and 100X (NA 0.9, WD 3.4 mm)
  - NUV: 15X (NA 0.32 WD 8.5 mm) and 40X (NA 0.5, WD 1 mm)
- Three searchable forensic, polymers and minerals spectral databases
- Macro sampling kit for measuring solids, powders and liquids in a cuvette, both in the visible and in the NUV.
- Polarization kits and analyzers for 785 and 532 laser lines
- **XYZ Mapping Stage**
  - stage with joystick and software control, that allows Raman imaging on surfaces ranging from 11.2 cm x 7.6 cm to 100 μm x 100 μm with a minimum step size of 0.1 μm (XY) and 16 nm on Z axis). The moving velocity on the 3 axes of the stage is automatically correlated with the magnification of the objective.
- Antivibration optical table (2.4x2 m)
- Software: Wire 3.4

NTEGRA Spectra AFM microscope

The AFM microscope is directly coupled to the Raman spectrometer for co localized AFM and Raman imaging simultaneously on the same pixel) on non-transparent samples (upright configuration). The system is ready prepared for TERS experiments.

Operating modes

- Contact, Non-contact, Semicontact
- Lateral Force Microscopy
- Phase Imaging
- Force Modulation Microscopy
- Adhesion Force Microscopy
- AFM Lithography and Nanomanipulation
- Magnetic force microscopy
- Electrostatic force microscopy
- Scanning Capacitance Microscopy
- Kelvin Probe Microscopy
- Spreading Resistance Imaging
- Atomic Force Spectroscopy

- Force distance curves
- Conductive Probe AFM
- Scanning tunneling microscopy

The Raman spectrometer is well suited for fast, analytical Raman spectroscopy. It is a fully integrated system designed for many applications, such as biomedical products, pharmaceuticals, forensics, electronics, chemicals, environmental samples, polymers and thin films. Confocal Raman spectroscopy, capable of obtaining data as a function of depth is available, being also possible to correlate Raman spectroscopy with surface topography using the AFM microscope.

The NT-MDT Ntegra Spectra SPM microscope supports both standard and advanced SPM imaging techniques. Well suited to measure surface characteristics of biomaterials, semiconductor wafers, lithography masks, magnetic and optical media and other organic and inorganic materials. Maximal scan size is 100 microns.

The following measurements (but not limited to) are possible:
Raman measurements:

- Common Raman and SERS measurements
- Raman imaging
- Photoluminescence measurements in the 200-1000 nm range
- Phase identification and discrimination of polymorphs
- Analysis of the effects of bonding, environment, and stress on a sample
- Point by point spectral mapping (confocal with lateral and depth resolution)
- Global imaging of an area for a selected wavelength
- Confocal Raman spectroscopic and photoluminescence point measurements (e.g. phase identification of transparent and opaque solids, fluid and solid inclusions; quantitative analysis of physical and chemical properties;
- Analysis of multi-point datasets (line scans, depth profiles, 2D and 3D maps to investigate or image the spatial distribution of phases or the changes in their physical and chemical properties);
- Non-destructive measurement of large (including archeological and art) objects

SPM measurements
AFM and STM microscopies
AFM Lithography and Nanolitrography Force
Conductive probe AFM microscopy
Surface topography and roughness
Adhesion measurements
Spreading Resistance and Scanning Capacitance (dC/dZ, dC/dV) Imaging
Scanning Kelvin probe microscopy
Force distance curves
Nanomanipulation STM
I/V spectroscopy, I(Z) spectroscopy etc.