UNIVERSITÀ DEGLI STUDI DI PALERMO

Advanced Technologies Network Center

CHAB mediterranean center for human health advanced biotechnologies

TECNOLOGIA RAMAN

Simonpietro Agnello

Raman Spectroscopy lab

Department of Physics and Chemistry – University of Palermo

https://fisicaechimica.unipa.it/agnello/

DiFC

28/09/2016

Laboratory of Advanced Materials Physics

Who am I ?

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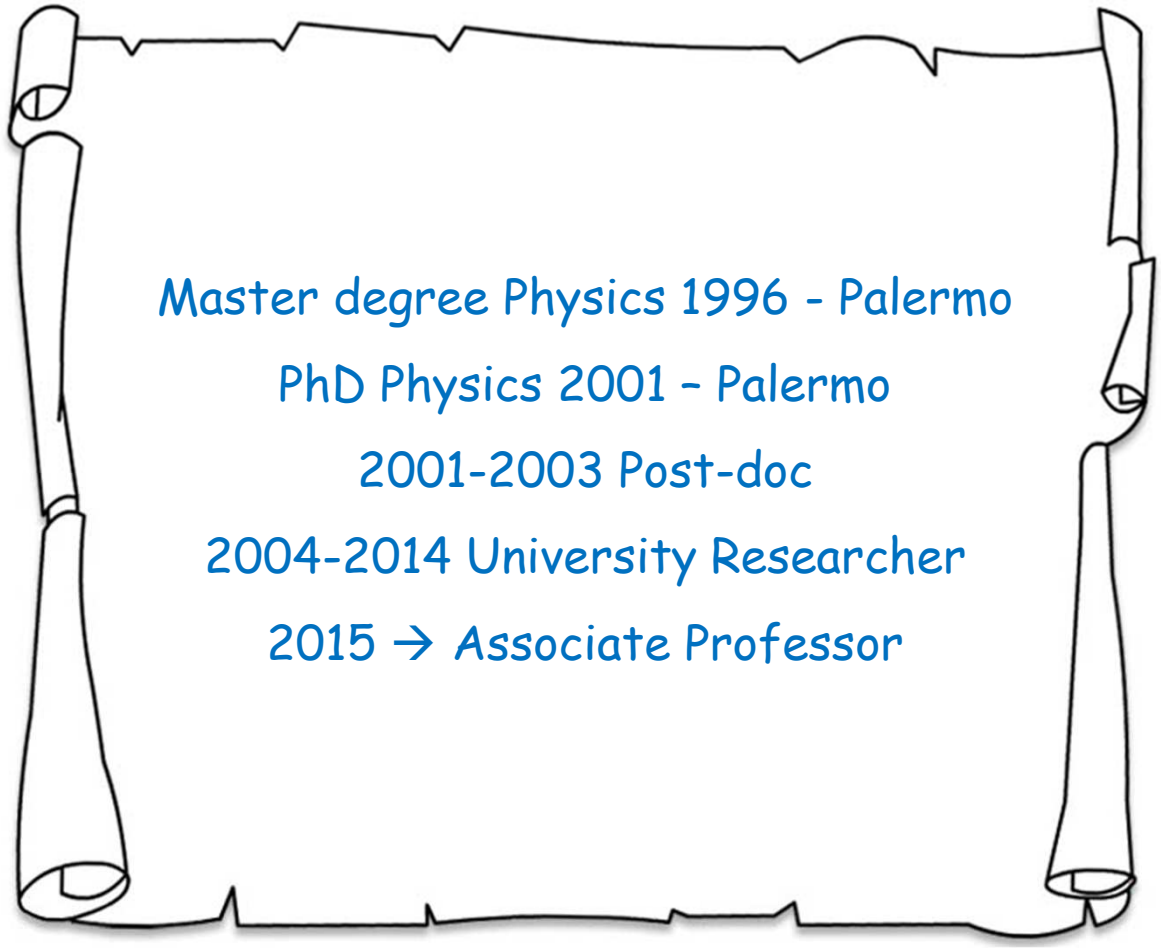

Master degree Physics 1996 - Palermo

PhD Physics 2001 – Palermo

2001-2003 Post-doc

2004-2014 University Researcher

2015 → Associate Professor

Who am I ?

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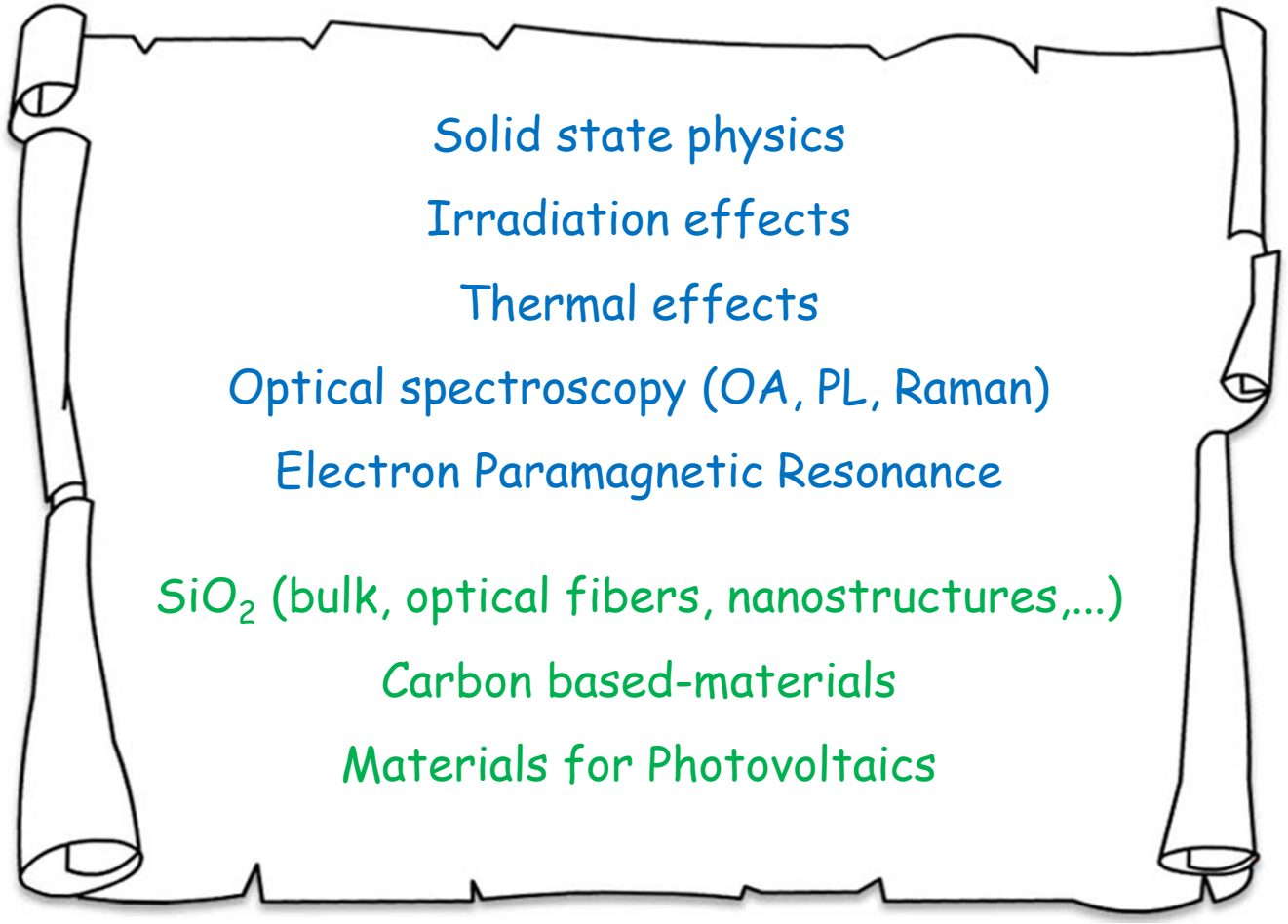

Who am I ?

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Laboratory of Advanced Materials Physics

Home | People | Research | Publications | Facilities | Downloads

http://www.unipa.it/lamp/

Welcome!

Last update: September 16, 2016

LAMP is a research group based in the **Department of Physics and Chemistry** at the University of Palermo. The expertise and the Scientific interests of the group lie across several areas of nanoscale physics, solid-state physics, Spectroscopy, Microscopy and material sciences. The ongoing experimental research activities of the LAMP group deal with the following subjects:

- Metal oxide nanoparticles
- Laser ablation in liquid phase
- Micro and meso-porous materials
- Carbon-based nanomaterials
- Silicon dioxide
- Optical fibers
- Materials for photovoltaics

The Raman effect

http://nobelprize.org/nobel_prizes/physics/laureates/1930/raman.jpg

The Raman effect was named after one of its discoverers, the Indian scientist **Sir Chandrasekhara Venkata Raman** who observed the effect by means of sunlight (1928).

Sir Raman won the Nobel Prize in Physics in 1930 for this discovery accomplished using sunlight, a narrow band photographic filter to create monochromatic light and a "crossed" filter to block this monochromatic light. He found that light of changed frequency passed through the "crossed" filter.

A New Type of Secondary Radiation, C. V. Raman and K. S. Krishnan, Nature, 121(3048): 501-502, March 31, 1928

What is Raman Spectroscopy ?

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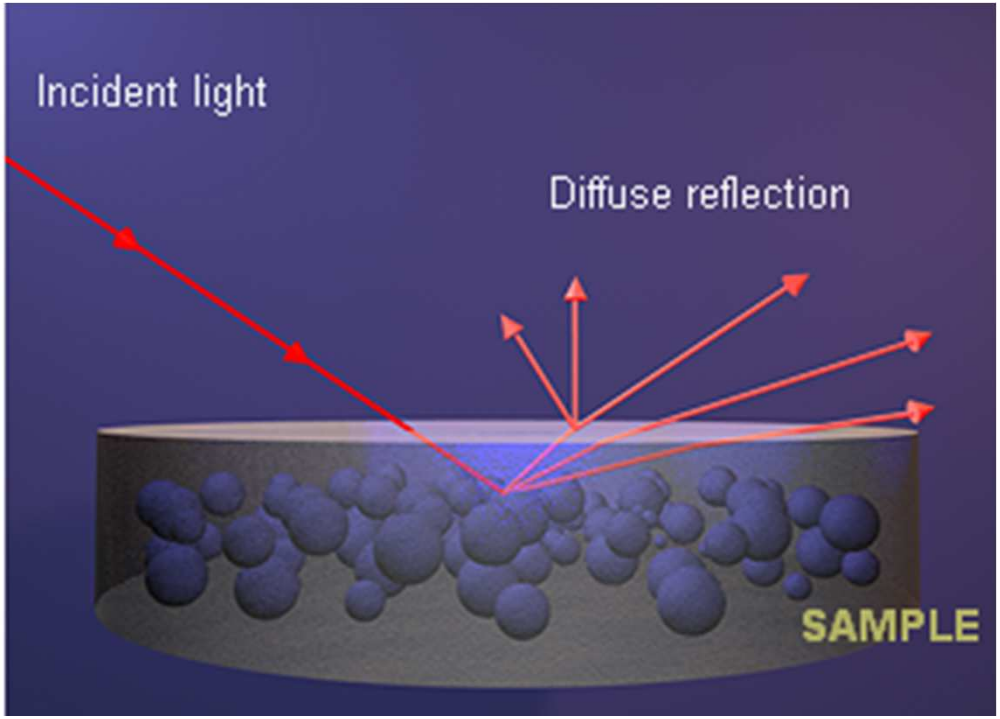

When light interacts

With matter

Exchange of energy could occur

What is Raman Spectroscopy ?

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The easiest case

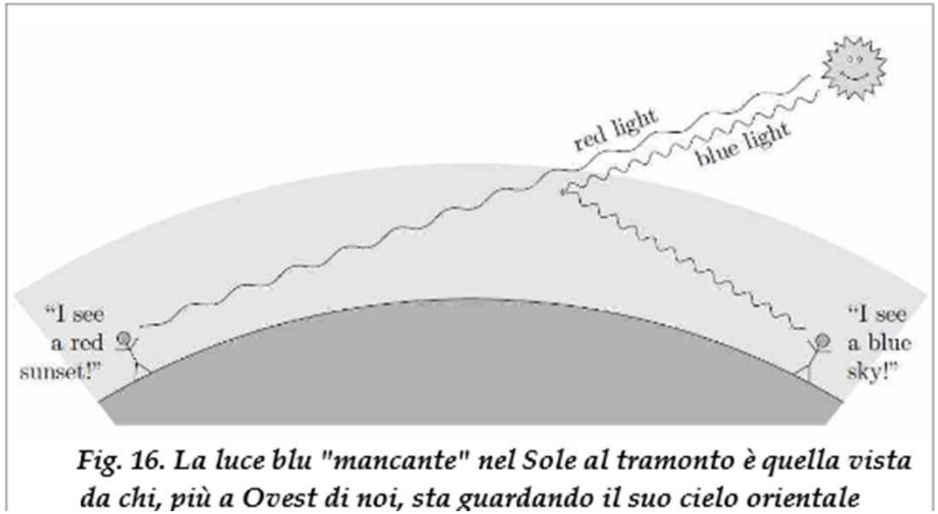

Fig. 16. La luce blu "mancante" nel Sole al tramonto è quella vista da chi, più a Ovest di noi, sta guardando il suo cielo orientale

Elastic scattering

NO ENERGY EXCHANGE

What is Raman Spectroscopy ?

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RAMAN EFFECT

The energy exchange OCCURS

$h\nu_1$

$h\nu_1 \neq h\nu_2$

$|h\nu_1 - h\nu_2|$ =energy of vibration/rotation

$h\nu_2$

What is Raman Spectroscopy ?

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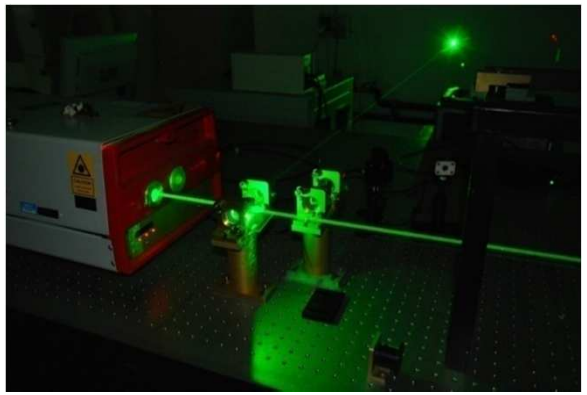
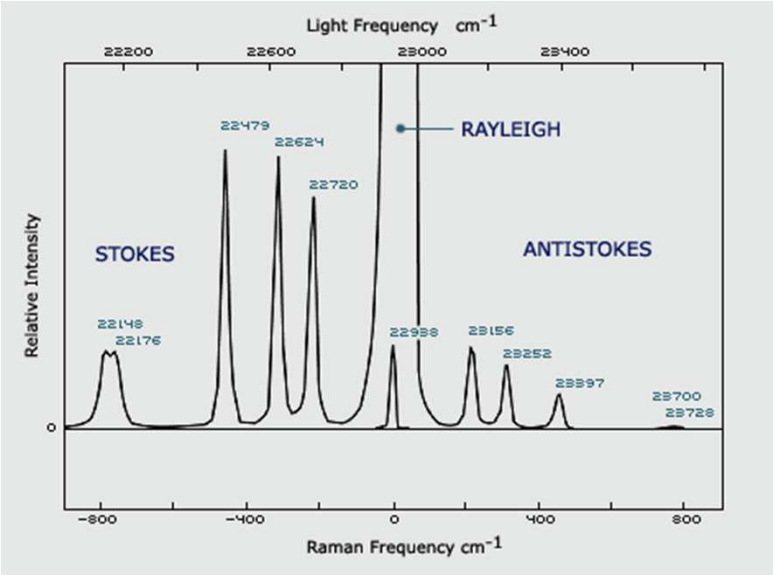
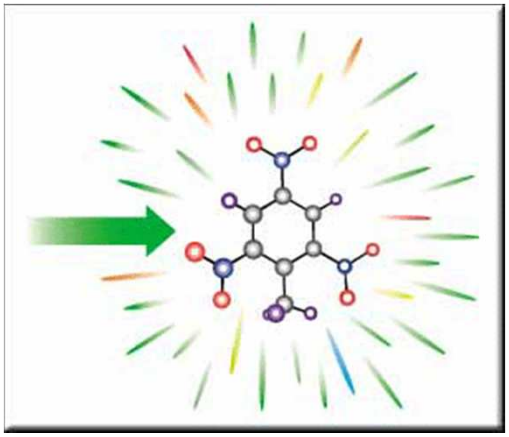


Using single energy photons (Laser light)

The energy exchange is "easily" measured





What is Raman Spectroscopy ?

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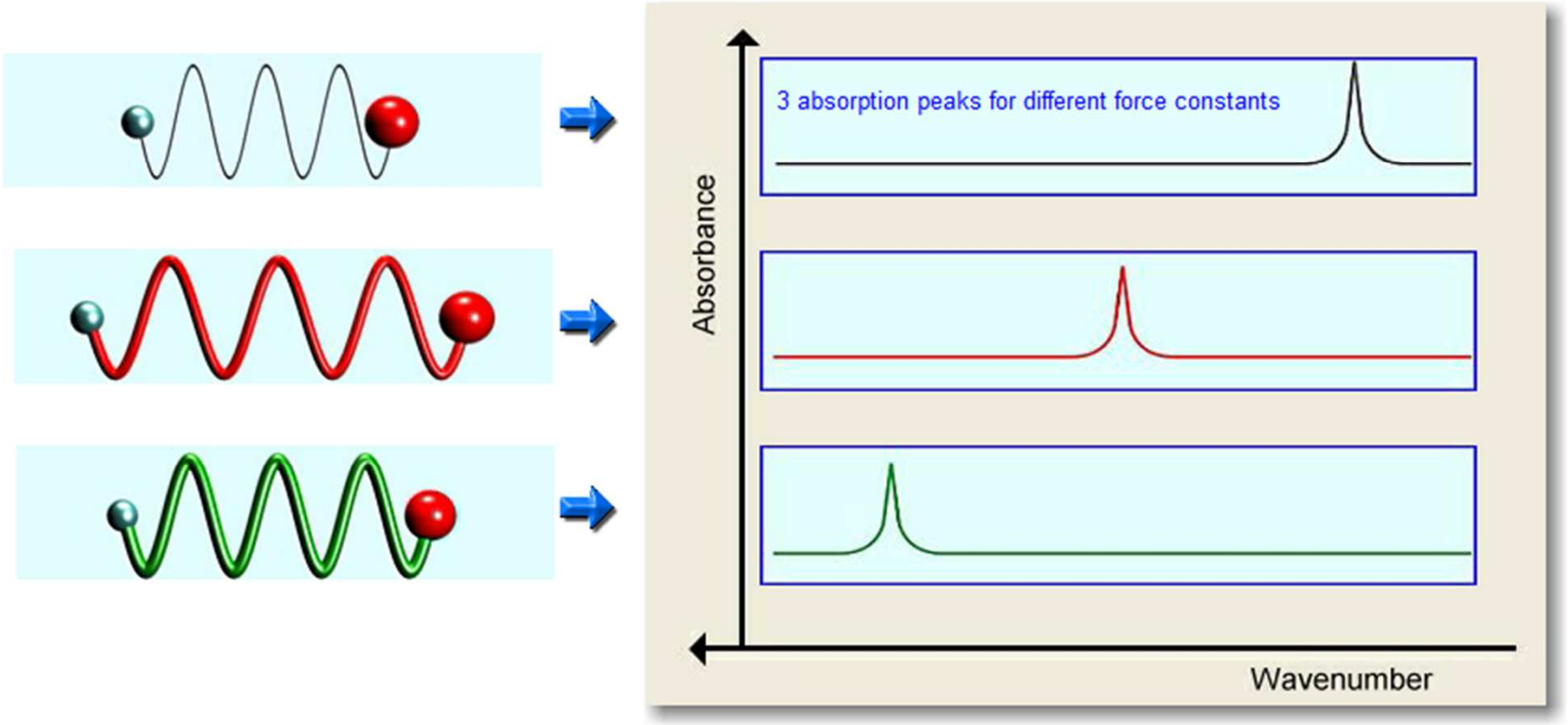
Vibration theory

1) The higher the force constant k, i.e. the bond strength, the higher the $\tilde{\nu}$ (in wavenumbers).



What is Raman Spectroscopy ?

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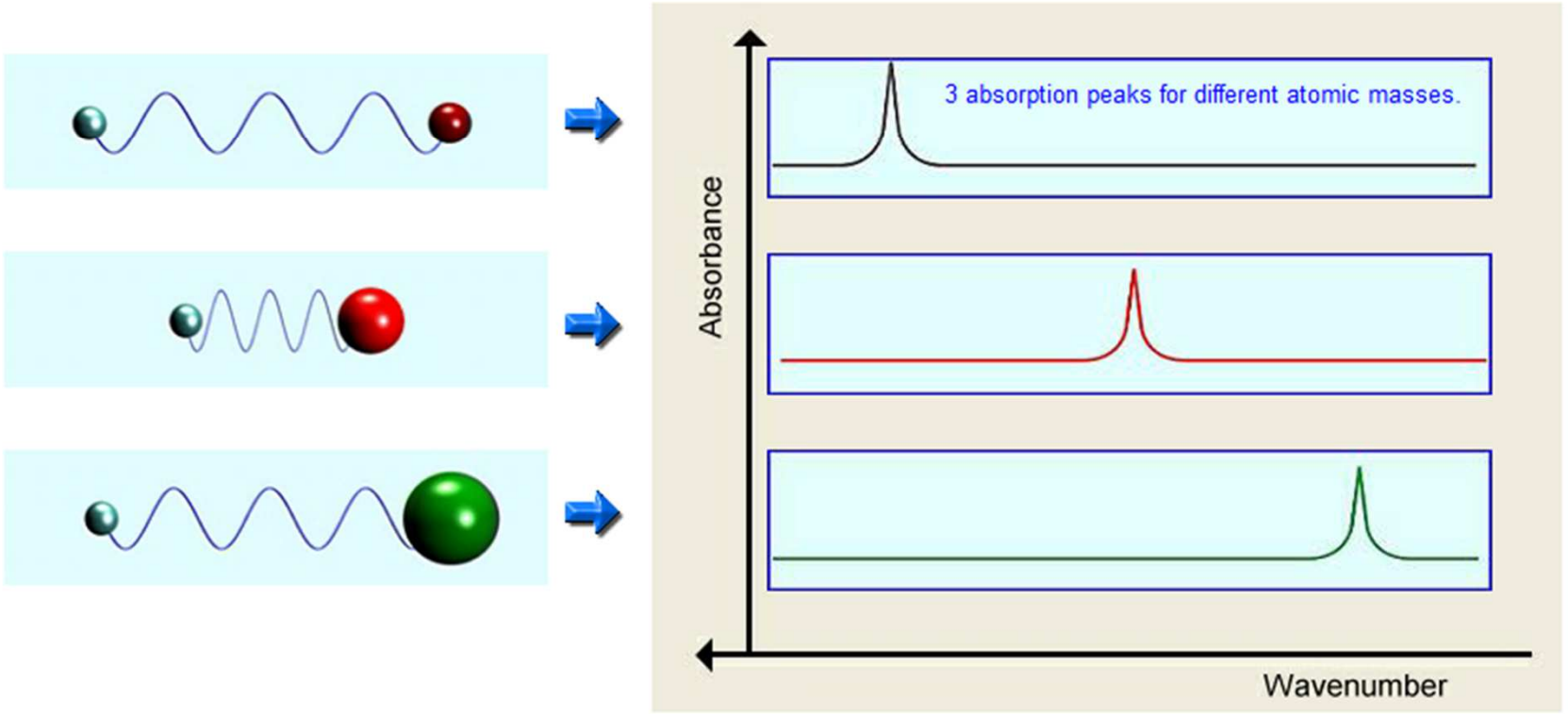
Vibration theory

2. The larger the vibrating atomic mass, the lower the vibrational frequency, $\tilde{\nu}$, (in wavenumbers).



What is Raman Spectroscopy ?

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Raman spectroscopy finds multiple applications thanks to the availability of LASER lines

It is a not invasive technique: **Safe for sample**, repetition of measurements

No sample preparation: gas, solid, liquid

Minimal samples quantitiy, also powder

NOT APPLIABLE TO METALS

Why Raman Spectroscopy ?

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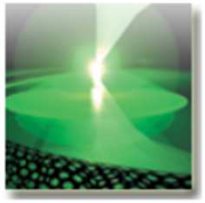
http://www.horiba.com/it/scientific/products/raman-spectroscopy/applications/

AFM/Raman



Art & Museums

Biology

Forensics

Geology

In situ analysis

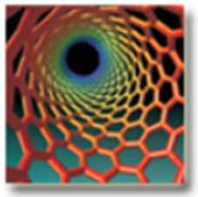
Carbon

Catalysis

Corrosion

Materials

Nano-materials



Polymers

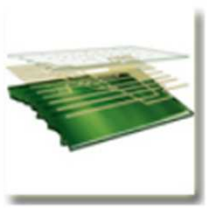
Energy

Environment

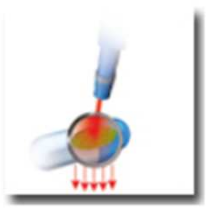
Food & Beverage

Pharmaceuticals

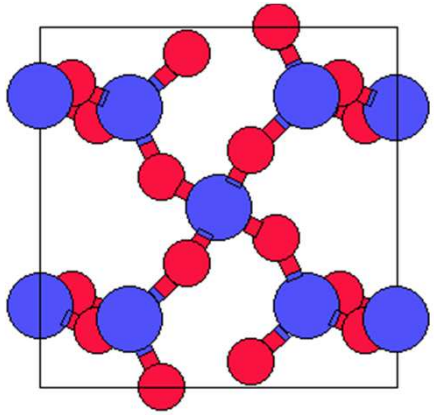
Semiconductors



Transmission



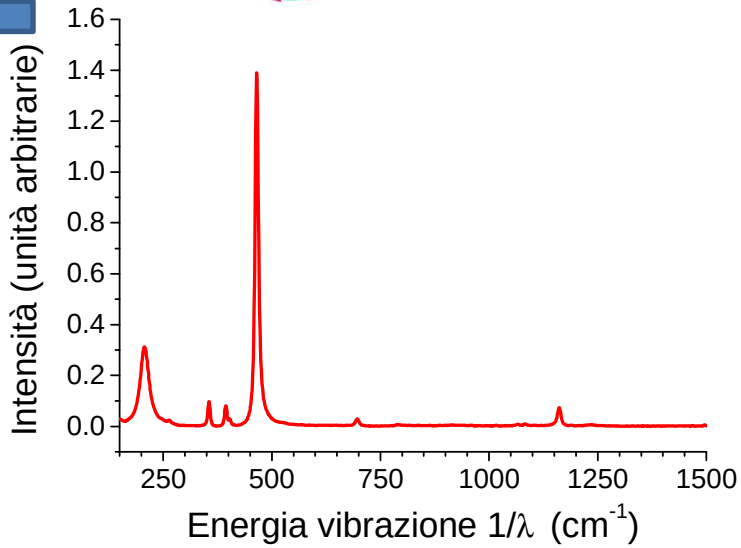
Why Raman Spectroscopy ?

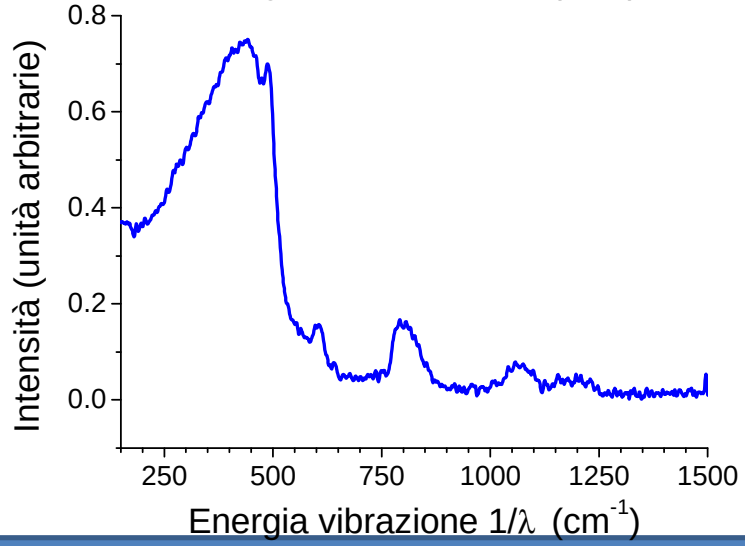


SiO_2

Crystal (quartz)

Amorphous (glass)





Why Raman Spectroscopy ?

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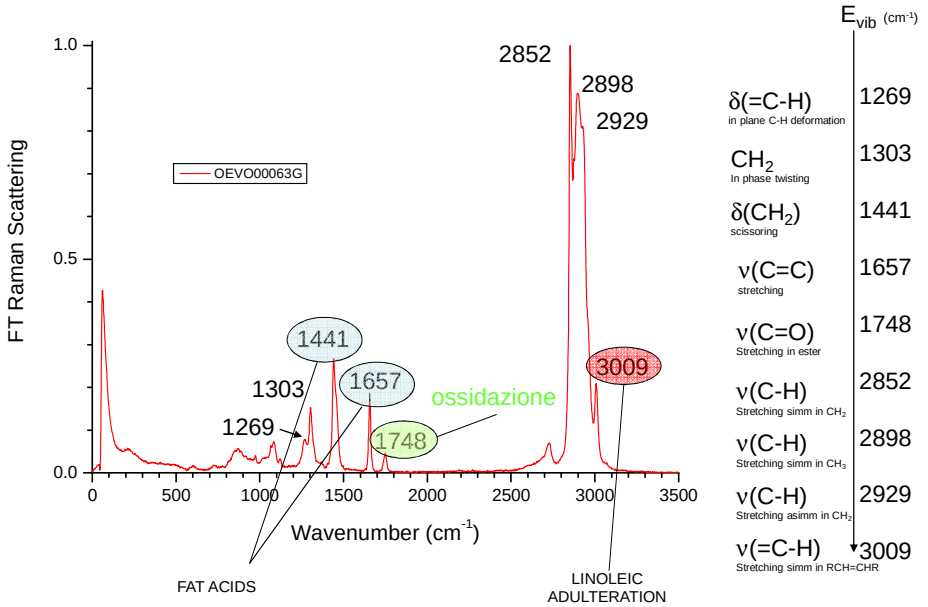
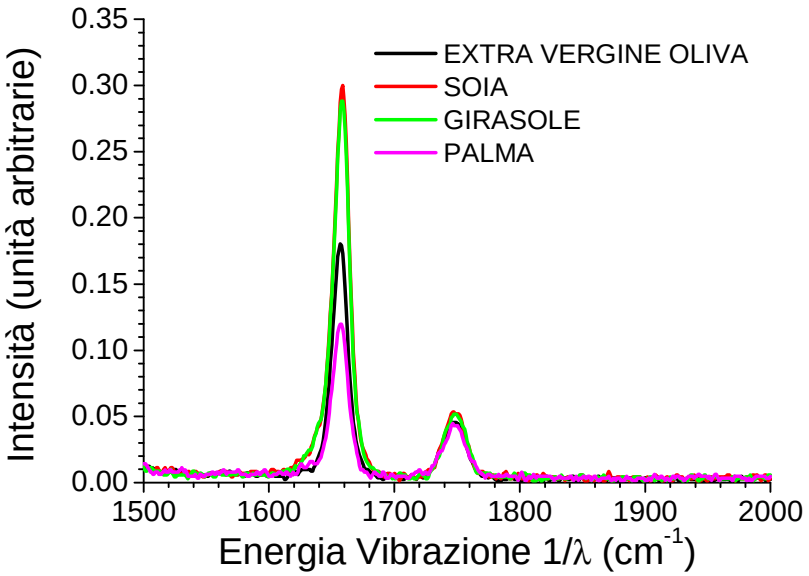
Natural oils





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RAMAN SPECTROSCOPY LAB (CHAB)

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Raman Spectroscopy LAB

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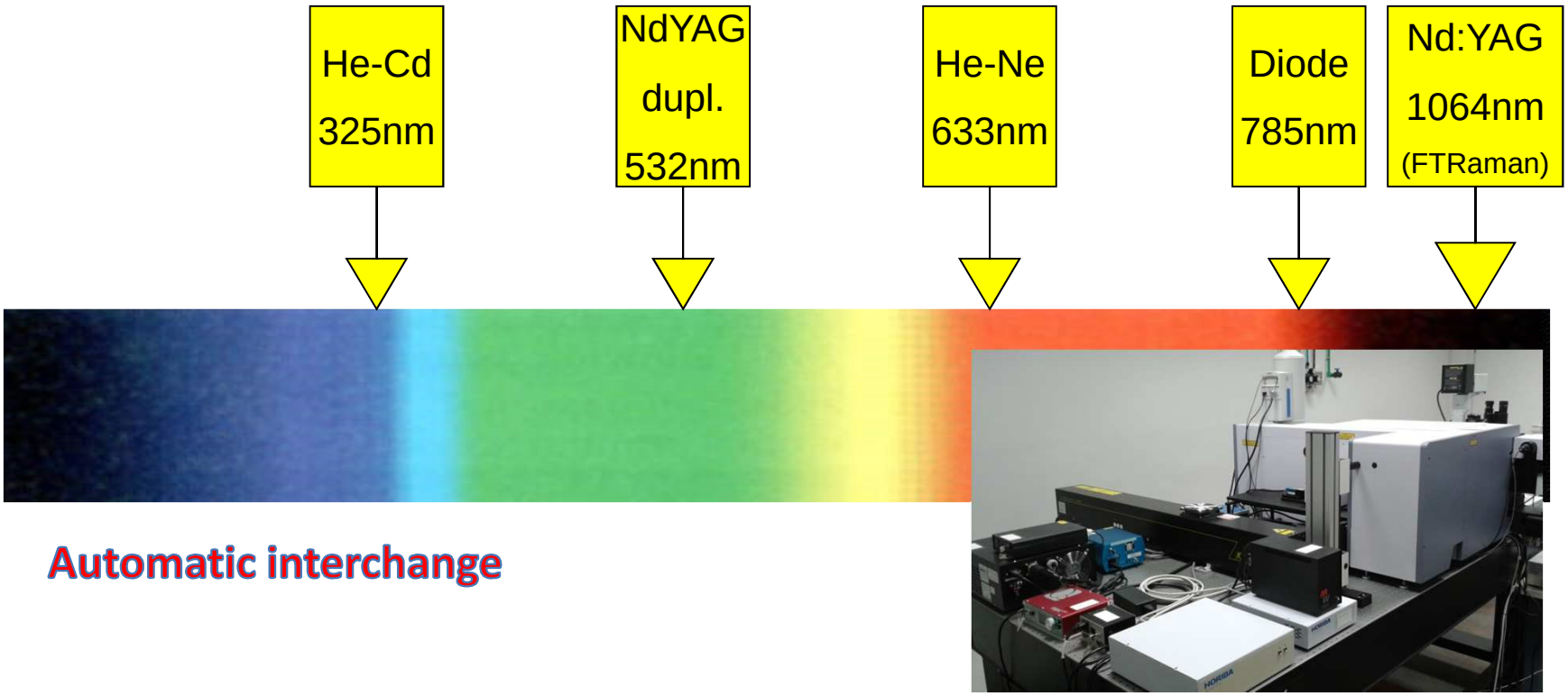
The NIR-UV MICRO-RAMAN LAB uses five excitation laser lines enabling materials analysis with high efficiency and avoiding fluorescence



Automatic interchange

Raman Spectroscopy LAB

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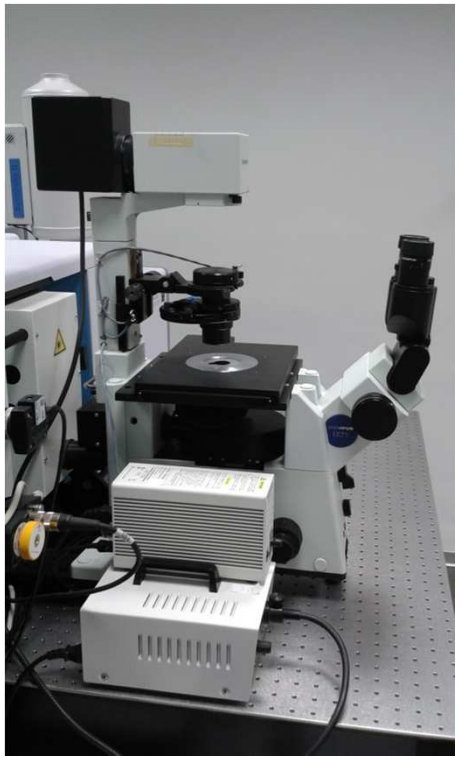
Two microscopes together with a wide set of objectives enables the study of any material type

Multipass cell holder

Upright – Open space
Large sample mounting



Inverted microscope

Raman Spectroscopy LAB

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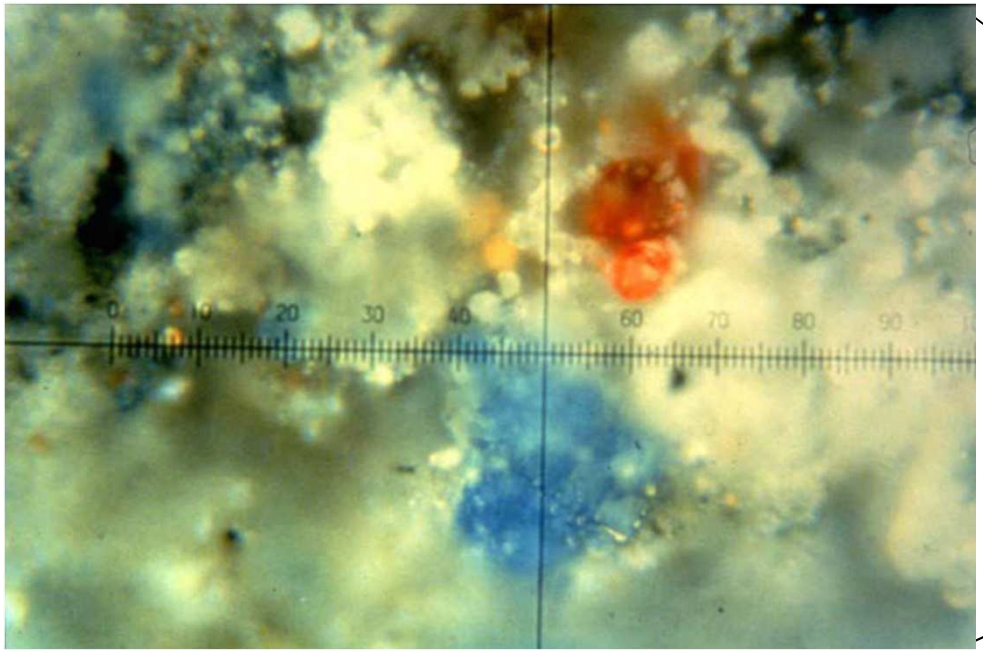

- Sample mapping with better than µm resolution
- high speed mapping, high spatial resolution

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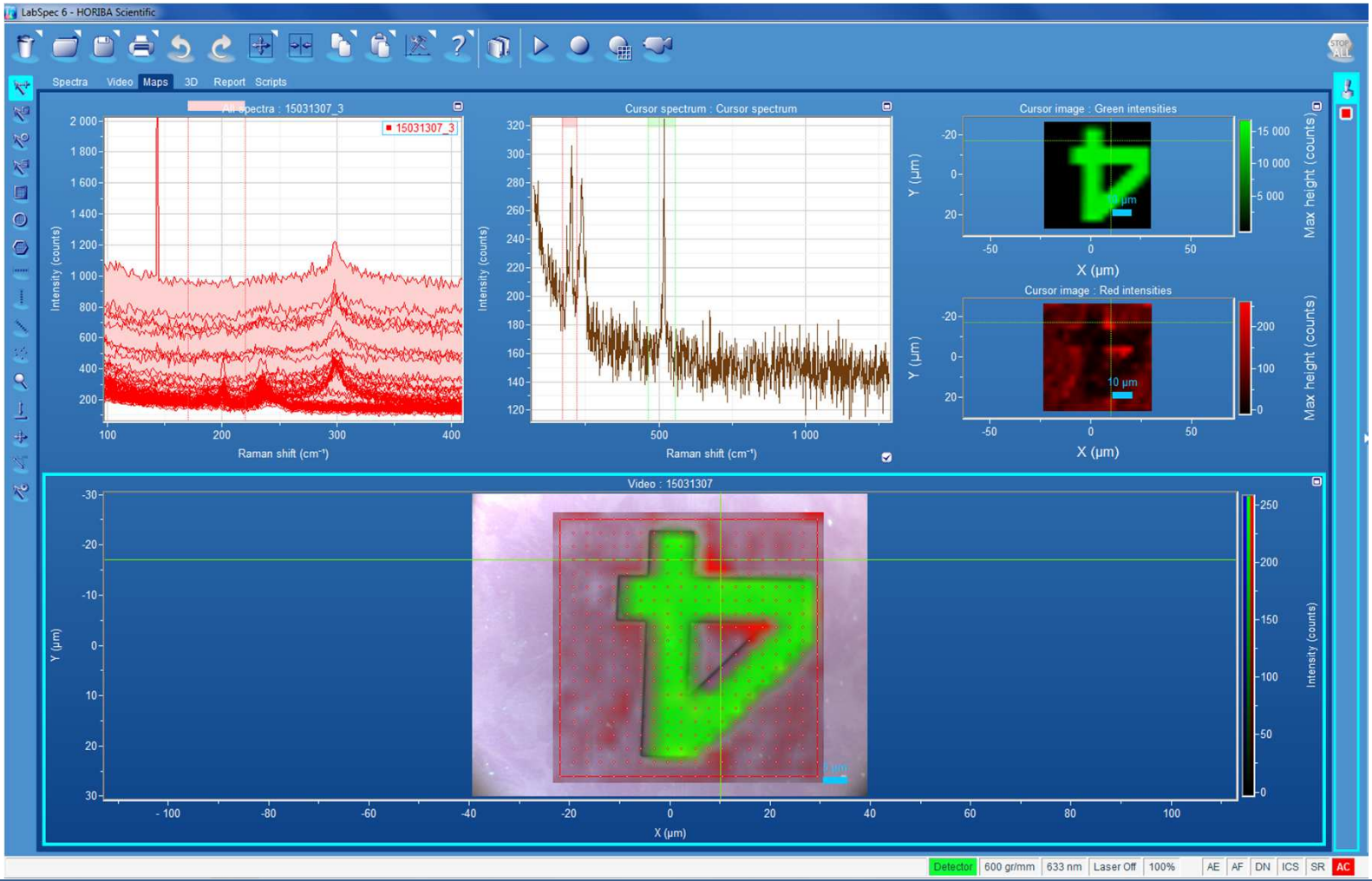

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Raman Spectroscopy LAB

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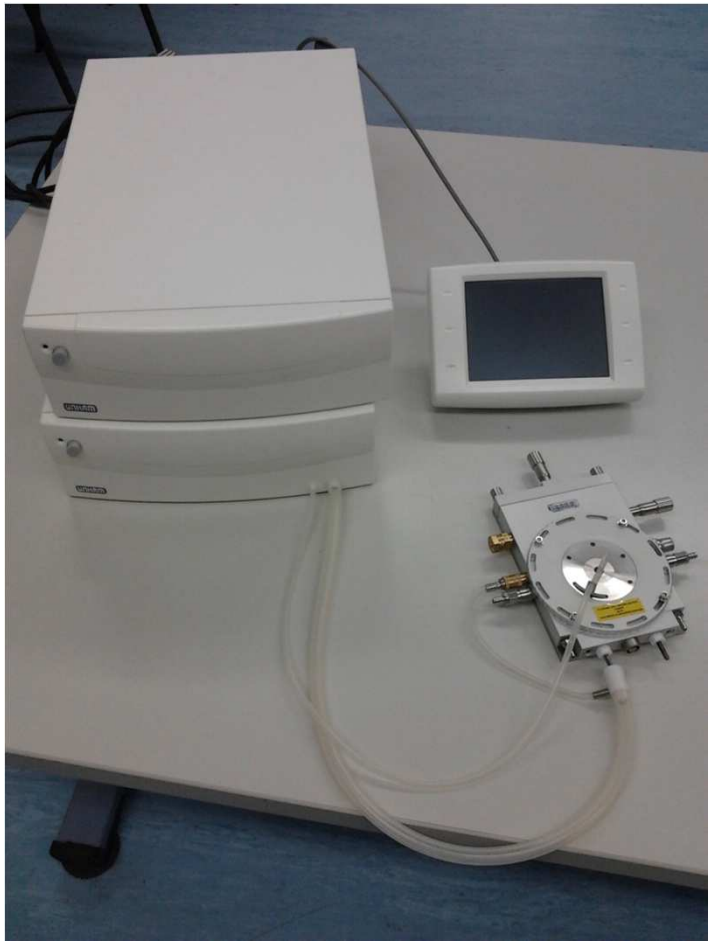

Temperature and gas pressure cell

Working T: 77 K – 873 K
Up to 14 bar
Enables to study thermal and atmosphere induced sample modification

Raman Spectroscopy LAB

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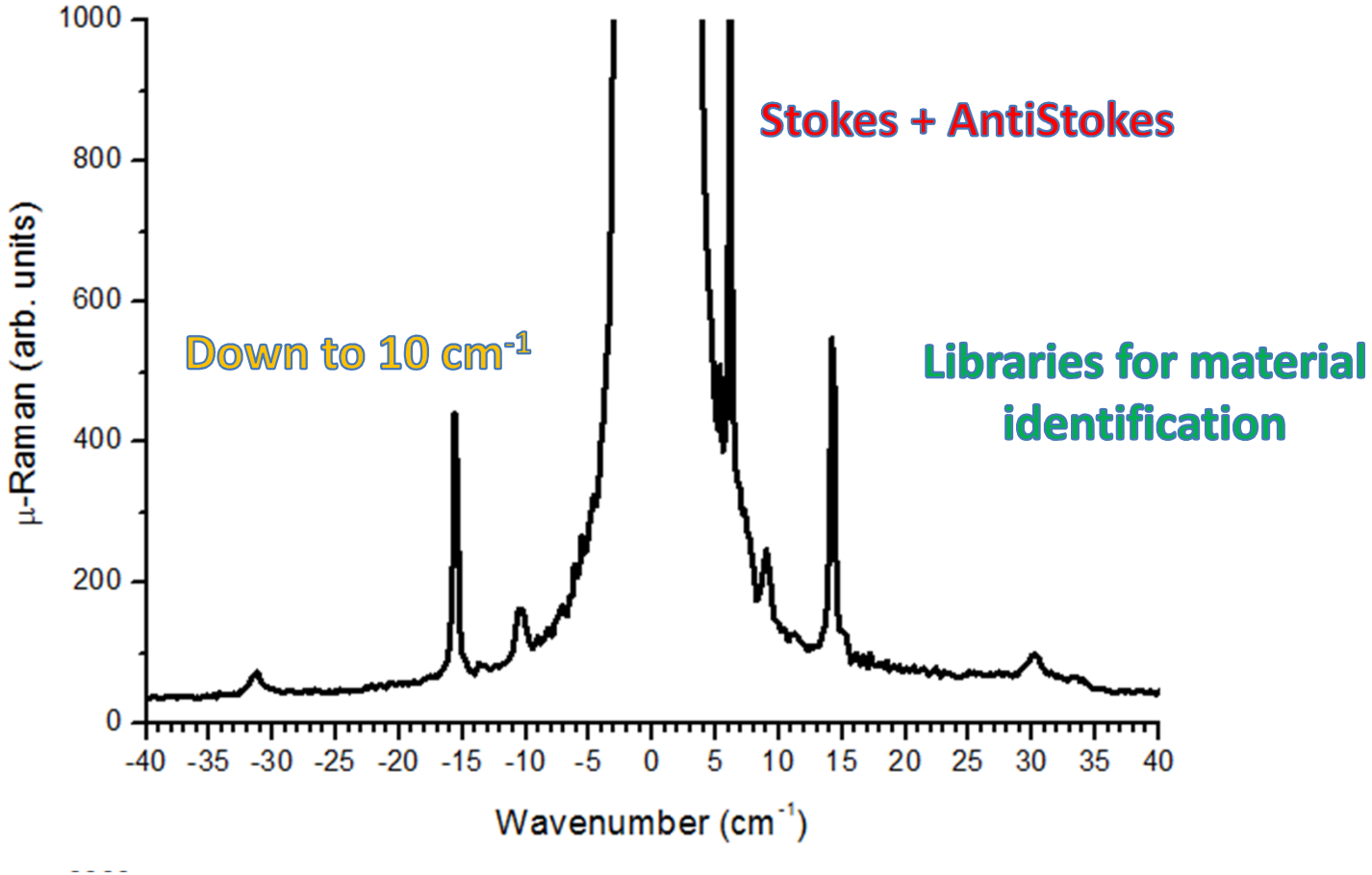
Wide spectral range and high spectral resolution enables characterization of any energy vibrations



AIMS

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LABORATORY	TOPICS	ACTIONS	OFFERED SERVICES	APPLICATIONS
Raman Spectroscopy Laboratory	**Principal:** **LIFESCIENCE** **PHARMACEUTICAL** **FOOD** **MATERIALS** **SEMICONDUCTOR** **FORENSIC** **ENVIRONMENT** **GEMOLOGY** **MINERALOGY** **CULTURALE HERITAGE**	**Not invasive Physical characterization of any material in gas, liquid or solid phase.** **Synergetic activity with the preparation and characterization labs of MEDCHHAB.** **Study of material properties and changes for companies or within research projects.** **Development of novel materials through their physical characterization.**	**Analysis of materials at the micrometric resolution both in small and large samples.** **- Material identification** **- Material characterization** **- Material analysis** **- Structural analysis** **- Spectroscopic 2D, 3D imaging** **- In-situ analysis during thermal treatment (-196÷600°C) in controlled atmosphere** **- Autonomous** **- With staff** **- Assisted**	**Material science, characterization and quality controls of the structural characteristics.**

TECHNICAL FEATURES

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LASER LINES	GRATINGS	MICROSCOPES	CELLS	SOFTWARE
(semi-automatic switch 10') ***1064 nm*** *(500mW)* ***785 nm*** *(100mW)* ***633 nm*** *(17mW)* ***532 nm*** *(100 mW)* ***325 nm*** *(200 mW)* *Dynamic range 0.01%-100%*	950 l/mm (NIR) 600 l/mm (NIR, VIS, UV) 1800 l/mm (NIR, VIS, UV) 2400 l/mm (UV) Stokes-Antistokes shift down to ~10 cm^{-1} for 785 nm, 633 nm, 532 nm	CONFOCAL UPRIGHT Olympus BXFM-ILHS: MOTORIZED XYZ LARGE SAMPLES INVERTED Olympus IX71: MANUAL XYZ	TEMPERATURE/PRESSURE LINKAM: (-196÷600°C) up to 14 BAR. 90° LIQUID CELL HOLDER	LABSPEC 6 BIORAD LIBRARIES
	DETECTORS	**OBJECTIVES**		
	Back-illuminated-deep-depletion CCDs: - Synapse (UV-VIS) - Symphony II (NIR) N_2 cooled	*VIS-UV* *10x (N.A. 0.25 W.D. 10.6)* *50x (N.A. 0.75 W.D. 0.38)* *100x (N.A. 0.90 W.D. 0.21)* *VIS-NIR* *20x (N.A. 0.5 W.D. 2.1)* *40x (N.A. 0.75 W.D. 0.51)* *UV* *40x (N.A. 0.5 W.D. 1)* *NIR* *50x (N.A. 0.55 W.D. 8)* *LWD VIS* *20x (N.A. 0.40 W.D. 26.5)* *50x (N.A. 0.50 W.D. 26.5)*		

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That's all

http://www.chab.center/home/

Grazie

28/09/2016