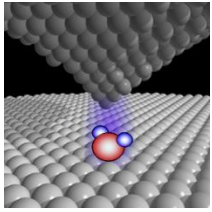


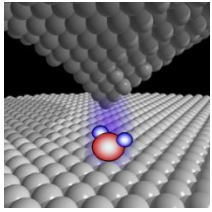
Research competences and resources at

Center of Surface Science and Nanotechnology (CSSNT)

University POLITEHNICA of Bucharest

Marius Enachescu, Prof. Dr.rer.nat.

About Marius Enachescu:



B.Sc. in Physics –"Magna cum laude" *(July 1982)*, University of Bucharest, Romania

M.Sc. in Physics –"Magna cum laude" *(July 1983)*, University of Bucharest, Romania

Ph.D. in Physics *(April 1994)*, Technical University of Munich, Germany
Thesis: " Scanning Tunneling Microscopy Studies of Light-Emitting Porous Silicon and Construction of a Special-Purpose Tunneling Microscope "
Adviser: Prof. Dr. R. J. Behm and Prof. Dr. Frederick Koch

Postdoctoral Research Associate, *(Jan. 1995-Dec. 1996)*
Laboratory of Surface Science and Technology, Sawyer Research Center, University of Maine

Postdoc Fellow, *(Jan. 1997-Nov. 1999)*
Materials Sciences Division, Lawrence Berkeley National Laboratory, University of California – Berkeley

Visiting Scientist/Professor, *(Dec. 1999- June 2009)*
Materials Sciences Division, Lawrence Berkeley National Laboratory, University of California – Berkeley

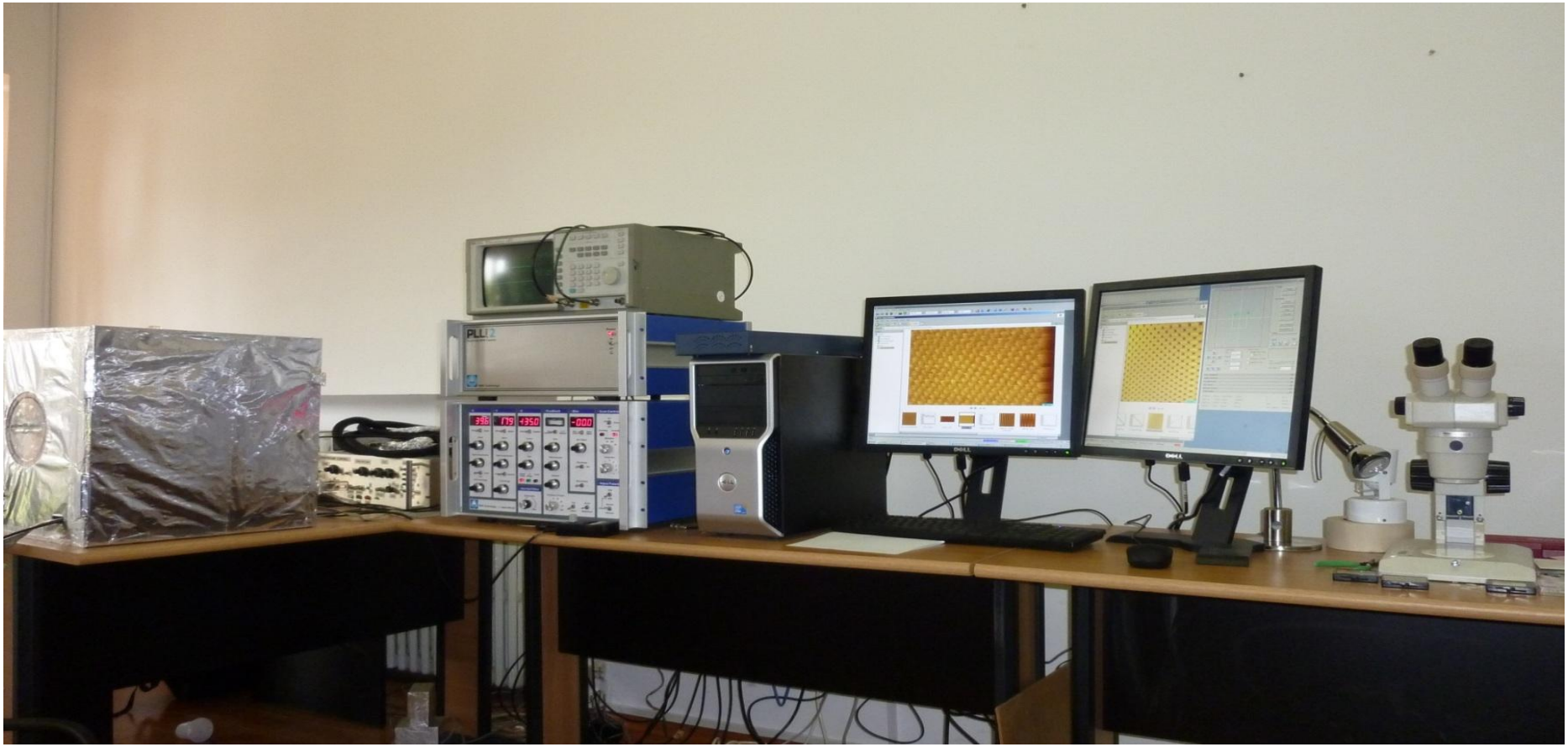
June 2009 returned back to Romania and back to European team!

Building a new lab and looking for European networking in order to exploit the European Union research funding opportunities!

About CSSNT Lab:

Center of Surface Science and Nanotechnology (CSSNT) is a very recent established entity

Atomic Force Microscope



AFM enclosure

Control electronics

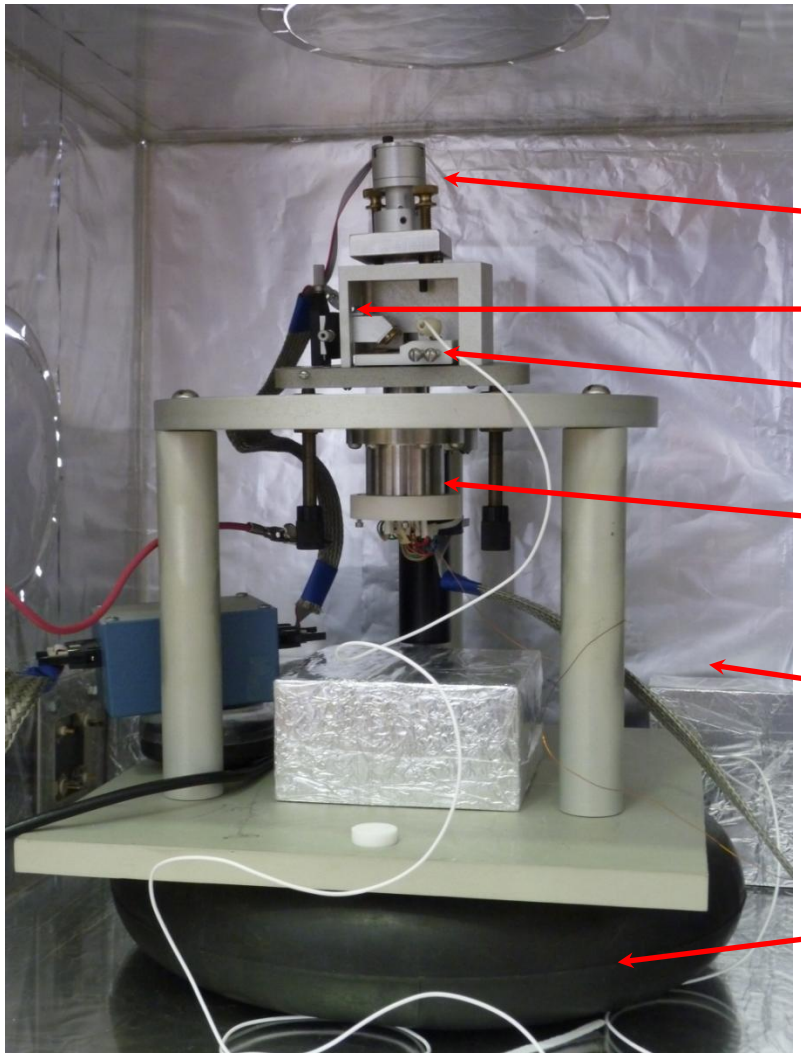
Image acquisition and processing

Sample and tip preparation

About CSSNT Lab:

Atomic Force Microscope

- home built -



LASER diode

Position Sensitive Photo-Detector

Tip holder

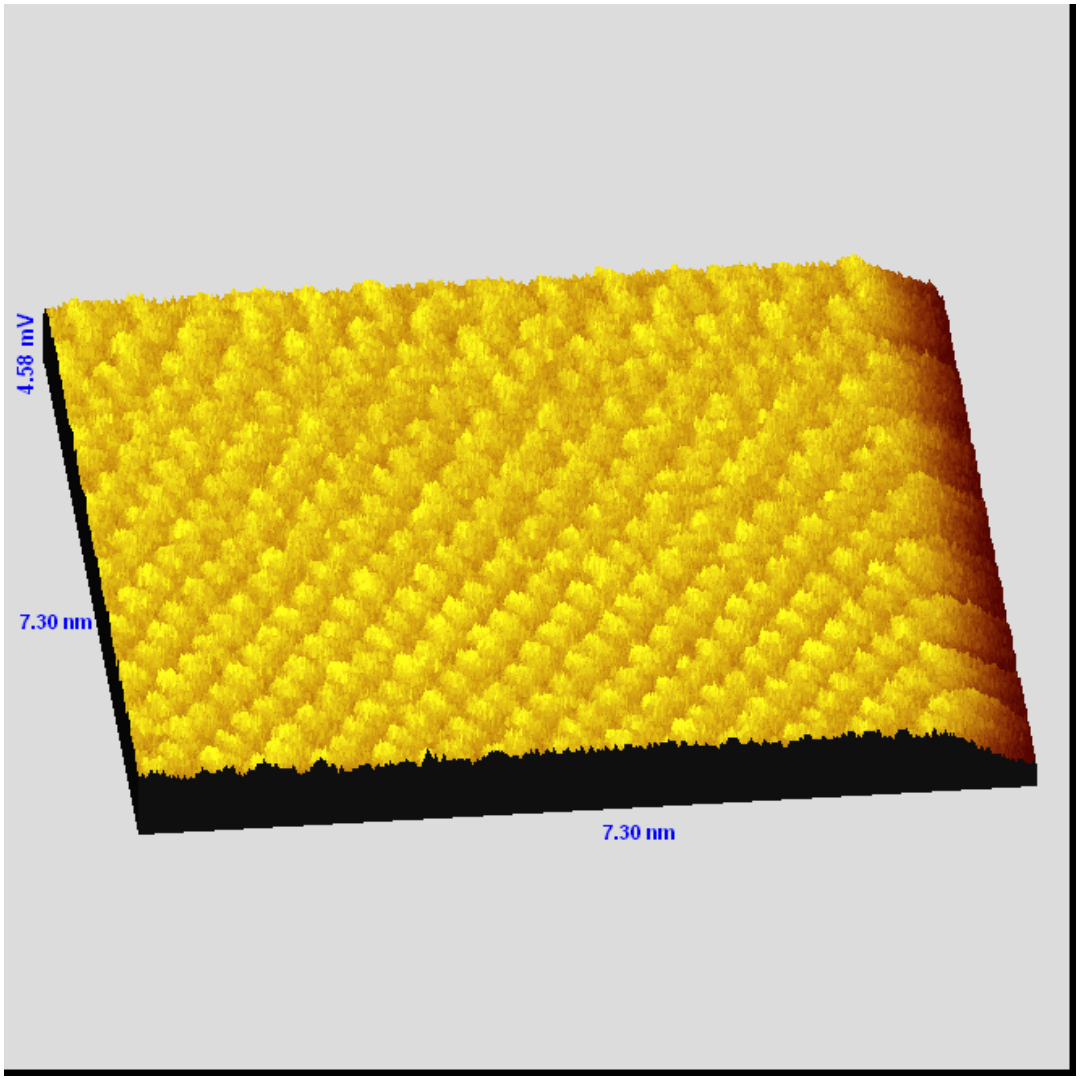
Scanner

Flexible environmental chamber

Vibration damping system

About CSSNT Lab:

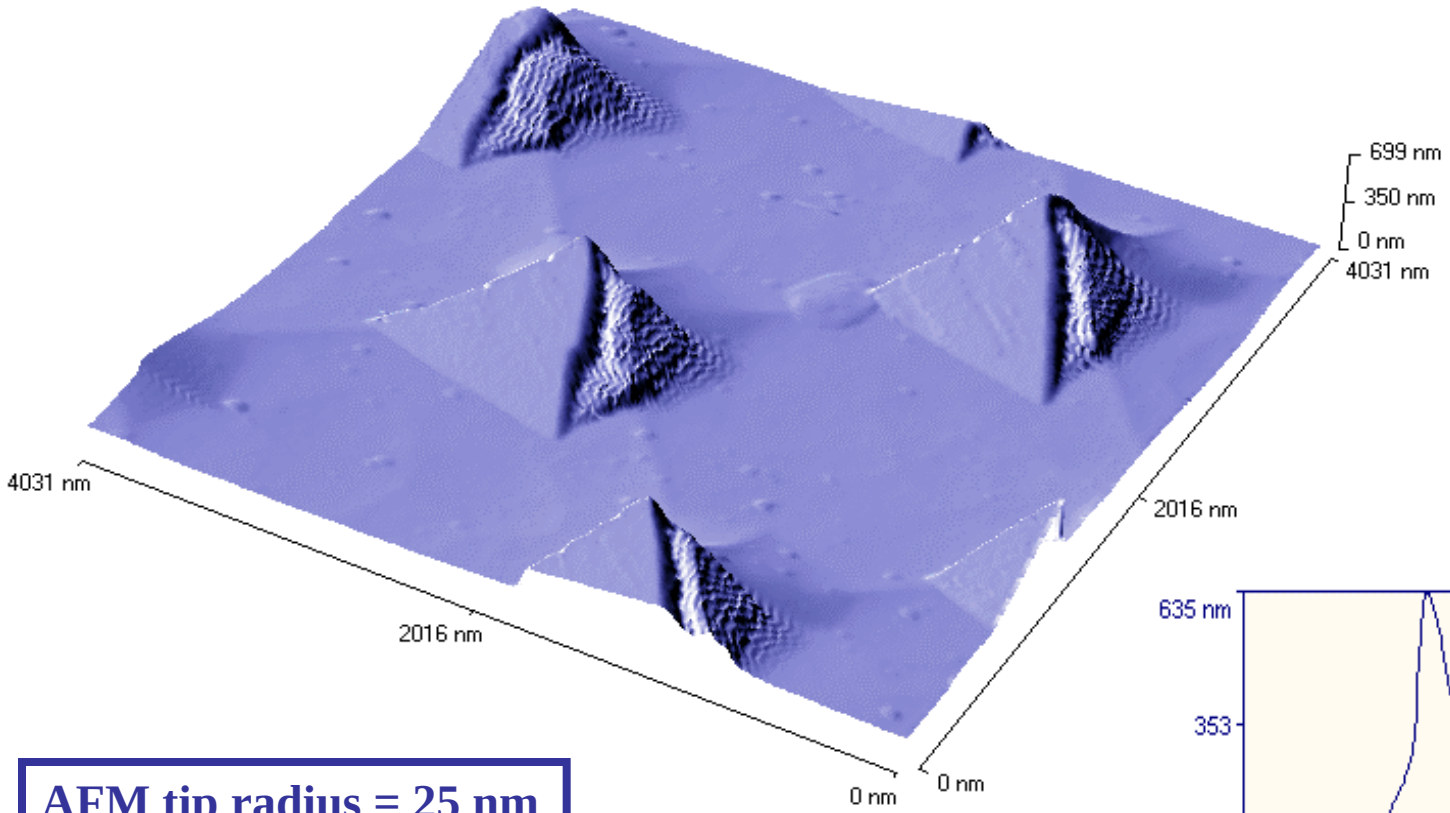
AFM Atomic Resolution

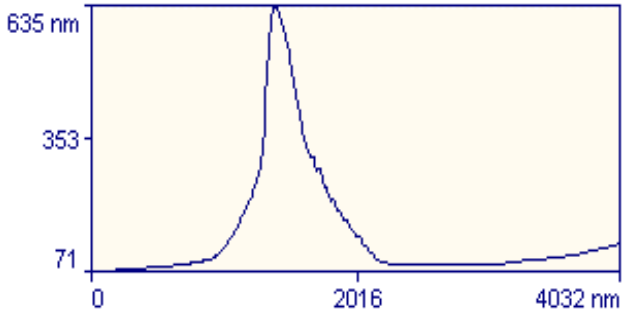


- Atmospheric pressure
- Room temperature
- Image made by viewing friction mode
- Stick-slip motion of the tip over the atomic lattice

About CSSNT Lab:

Measuring AFM tip radius

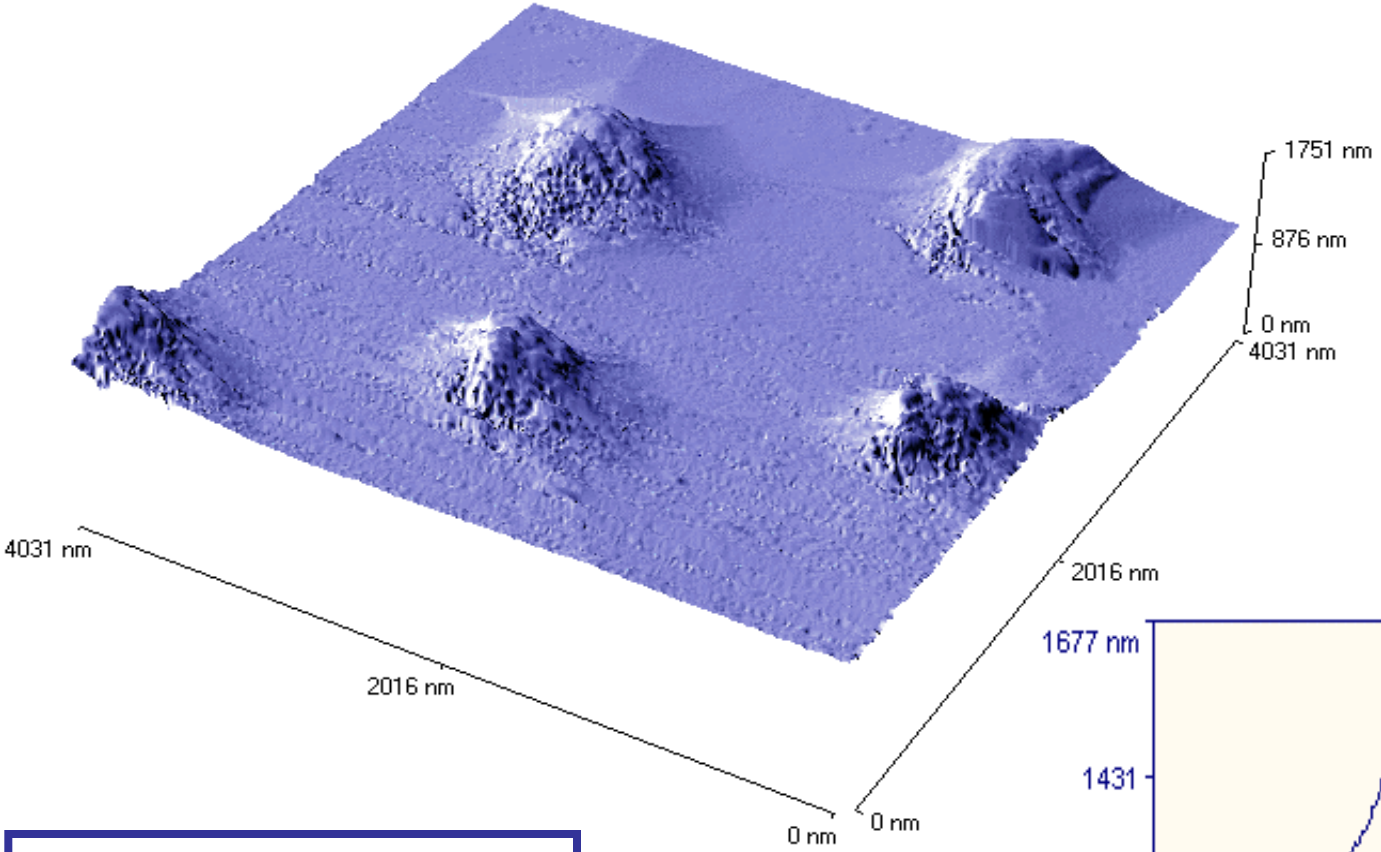


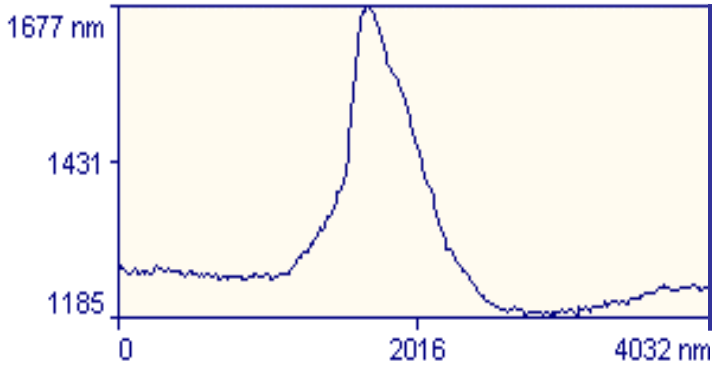


AFM tip radius = 25 nm

About CSSNT Lab:

Measuring AFM tip radius

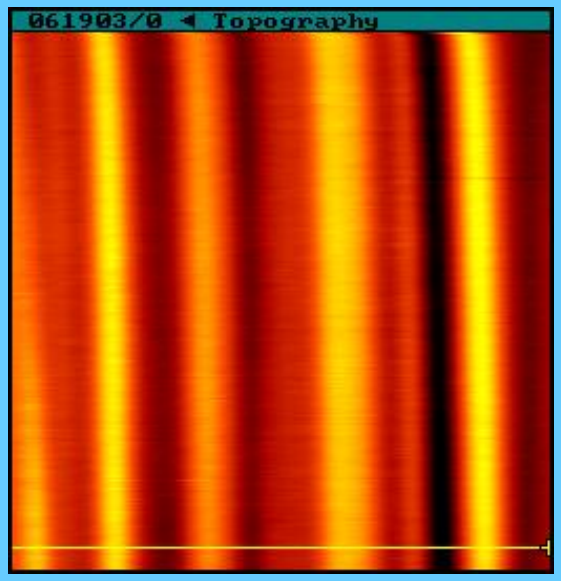


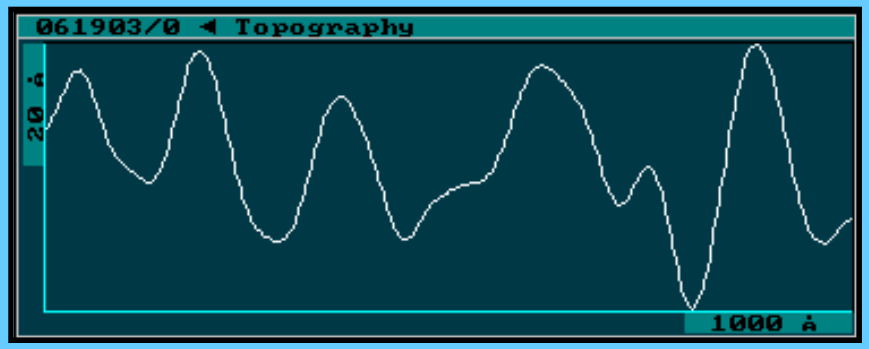


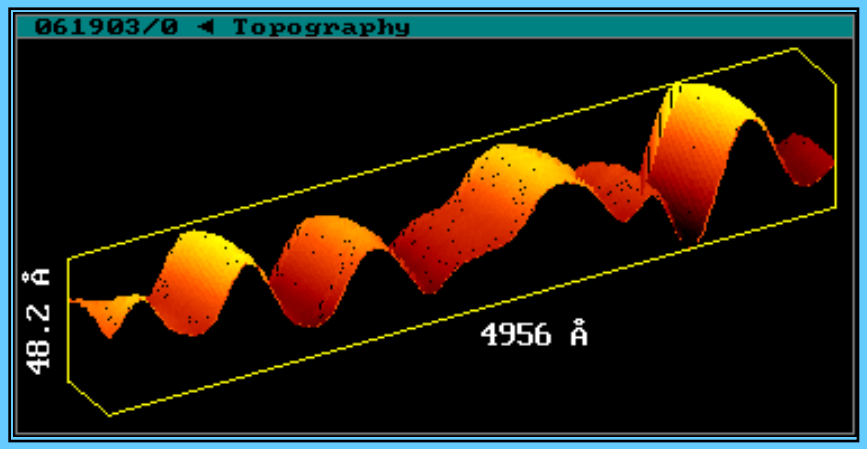
AFM tip radius = 300 nm

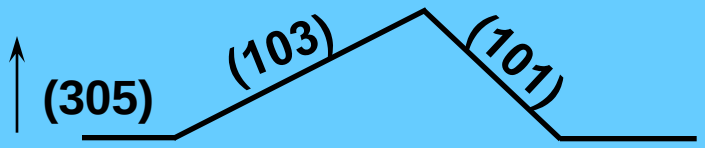
Measurement of the AFM Tip Radius

SrTiO3-sample









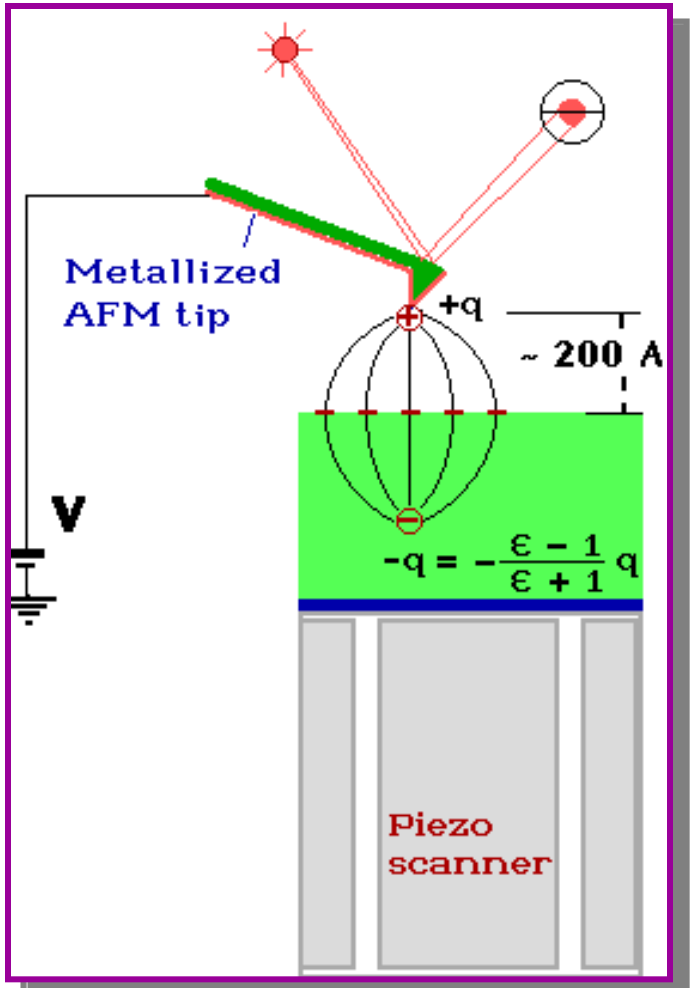
Θ(103)=12.5 degree Θ(101)=14.0 degree

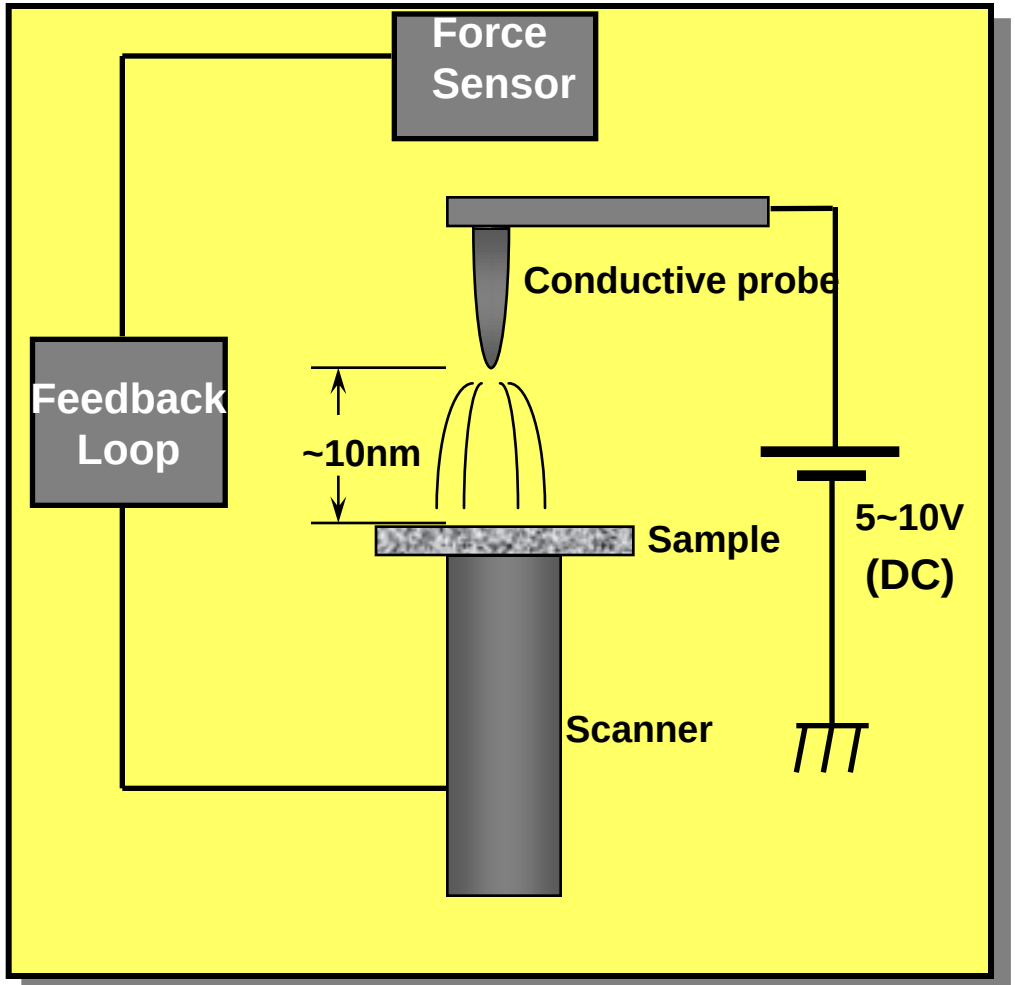
atomically flat sloped facets

Radius of Curvature: R ~ 160 nm(k=88 N/m)
R ~ 110 nm(k=0.23 N/m)

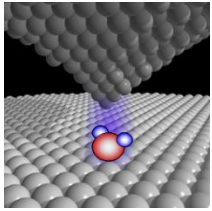
About CSSNT Lab:

Scanning Polarization Force Microscopy (SPFM)





About CSSNT Lab:



Scanning Polarization Force Microscopy (SPFM)

Image Contrast

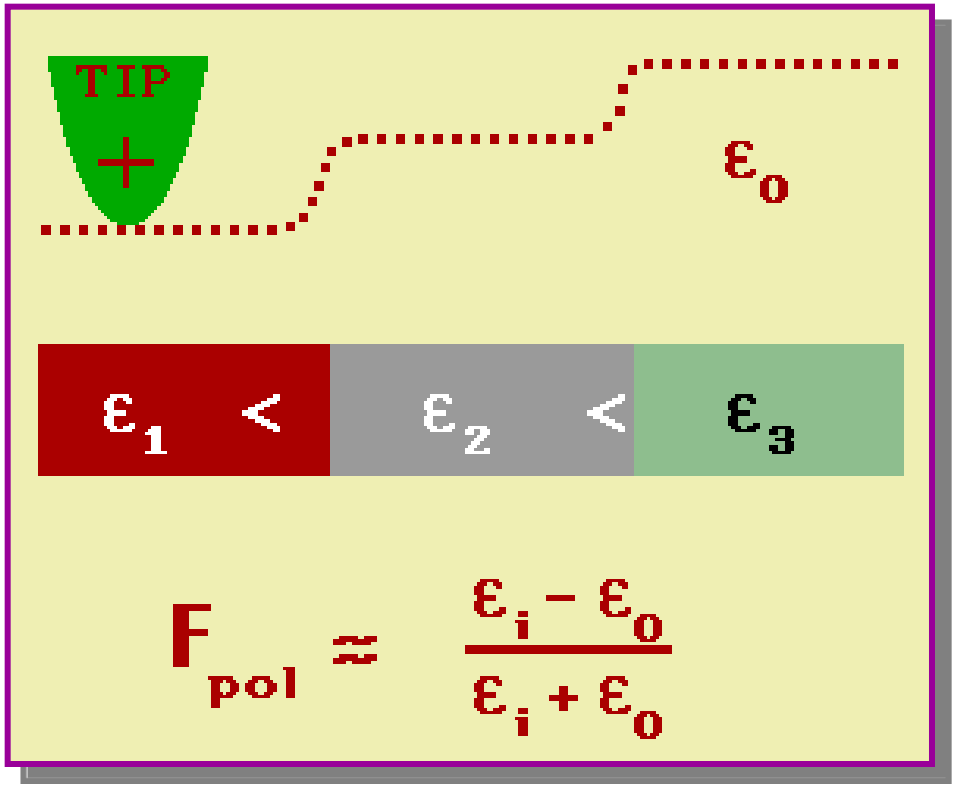
$$F = -4\pi\varepsilon_0 \cdot \frac{\varepsilon - 1}{\varepsilon + 1} \cdot f\left(\frac{R}{z}\right) \cdot (V_{tip} - V_{sample})^2$$

When ε>>1, F is insensitive to ε.

Dielectric Spectroscopy
Freq. Dependence of ε(ω)

ωres >>> topography
ω >>> contact potential
2ω >>> ε mapping

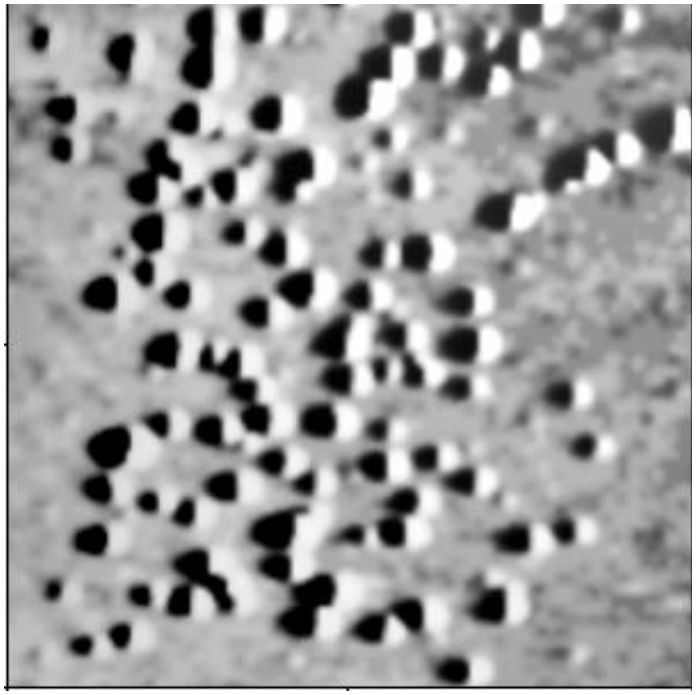
simultaneously



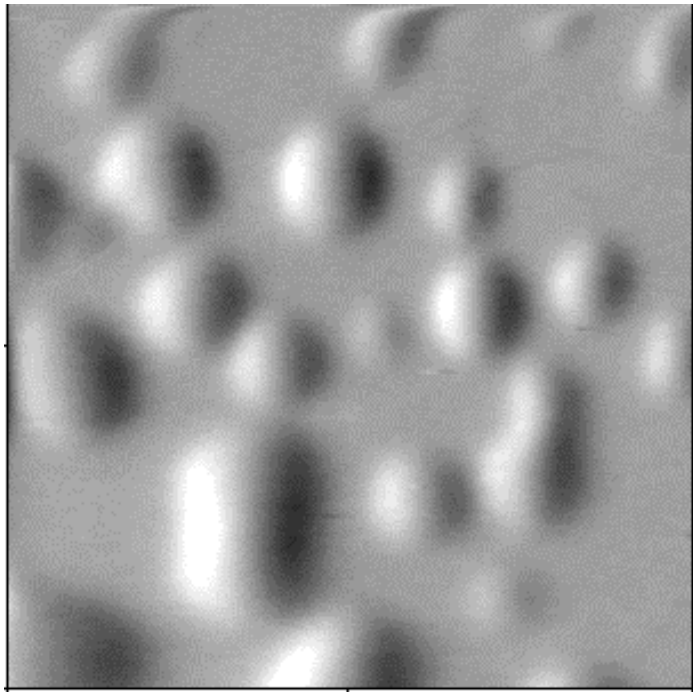
About CSSNT Lab:

"TOUCHING" Liquid Surfaces - Glycerol

Results of SPFM-DC implemented technique



18,7μm x 18,7μm

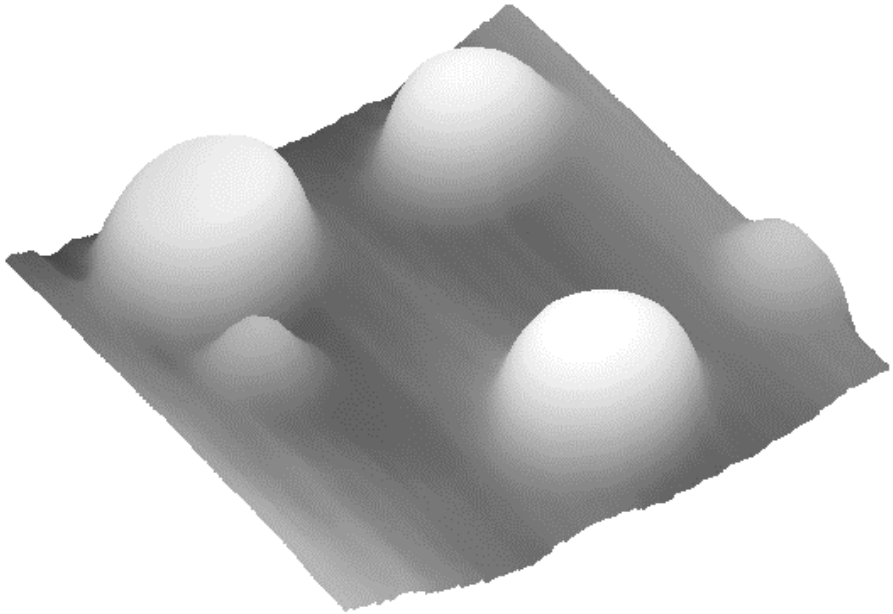


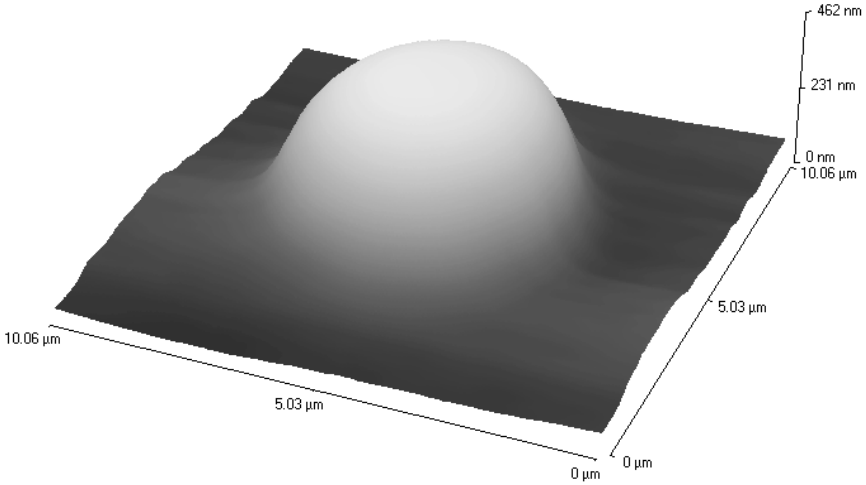
9μm x 9μm

About CSSNT Lab:

Study of Glycerol Droplets

Results of SPFM-DC implemented technique





5µm x 5µm; imagine 3D

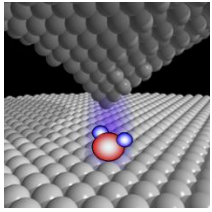
2,5µm x 2,5µm; imagine 3D

About CSSNT Lab:

Micro-Raman Spectroscopy

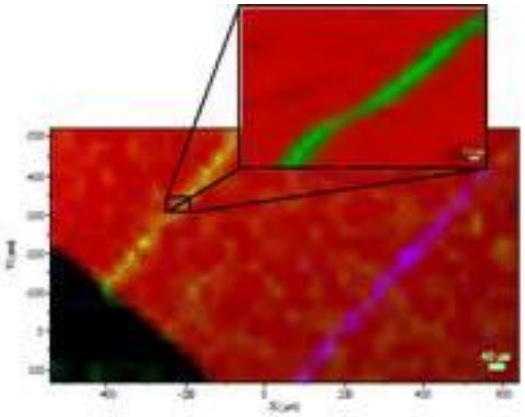
- 800 mm focal length spectrograph equipped with two switcheable gratings
- spectral range: 200nm - 1600nm
- spectral resolution:
  - UV: 1.5cm^-1
  - VIS: 0.6cm^-1
  - NIR: 0.3cm^-1
- excitation sources: 633nm, 17mW; 532nm, 50mW

About CSSNT Lab:



Micro-Raman Spectroscopy
Confocal Fluorescence Microscopy

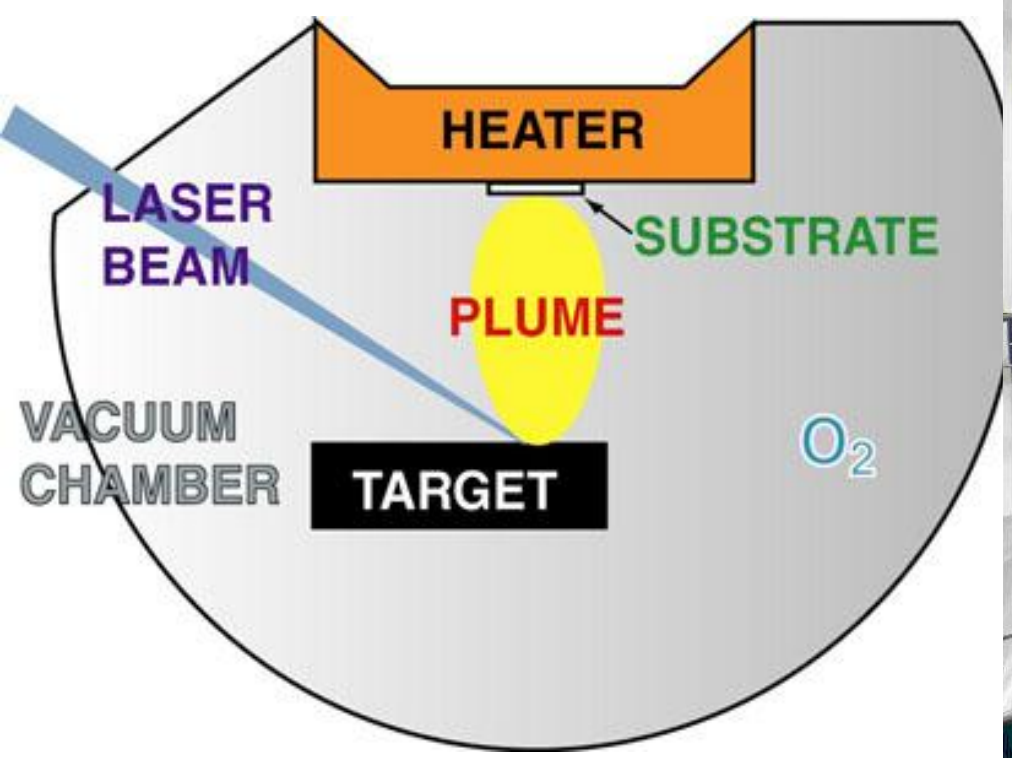
- Confocal Raman microscopy is able to capture the space distribution of CNT with different electronic structures
- No preparation of the sample required.
- Great spatial resolution.
- Clear image quality.
- Outstanding chemical differentiation.
- Ability to perform 3D mapping of bulk sample

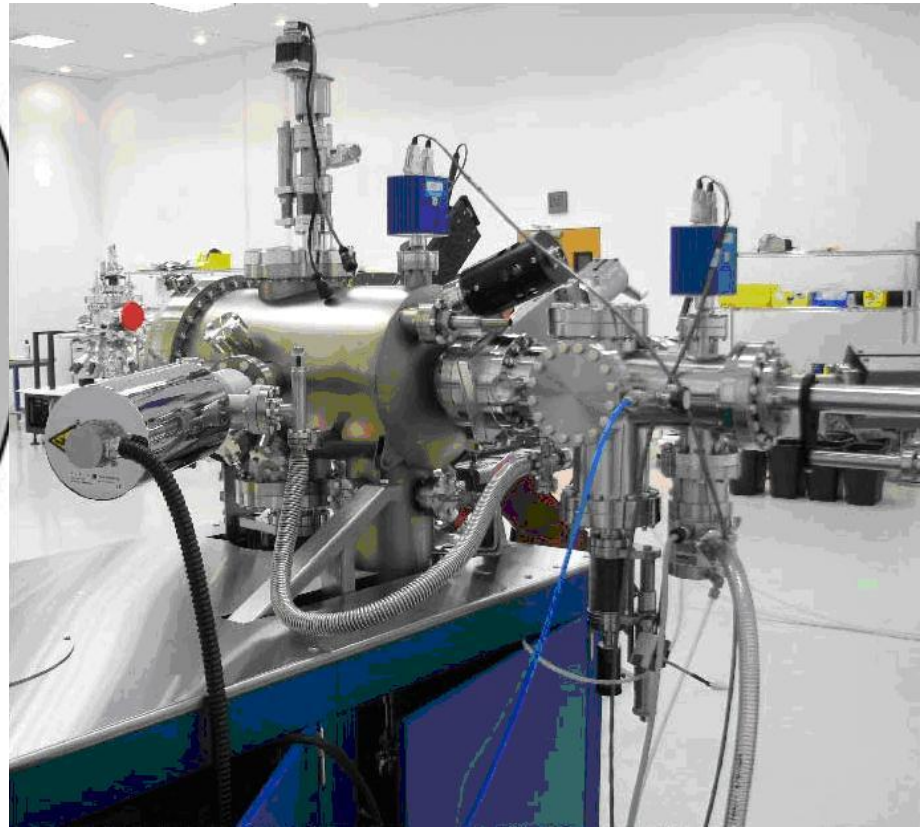


Isolated SWCNTs aligned on a Silicon sample

About CSSNT Lab:

"MBE" Pulse Laser Deposition

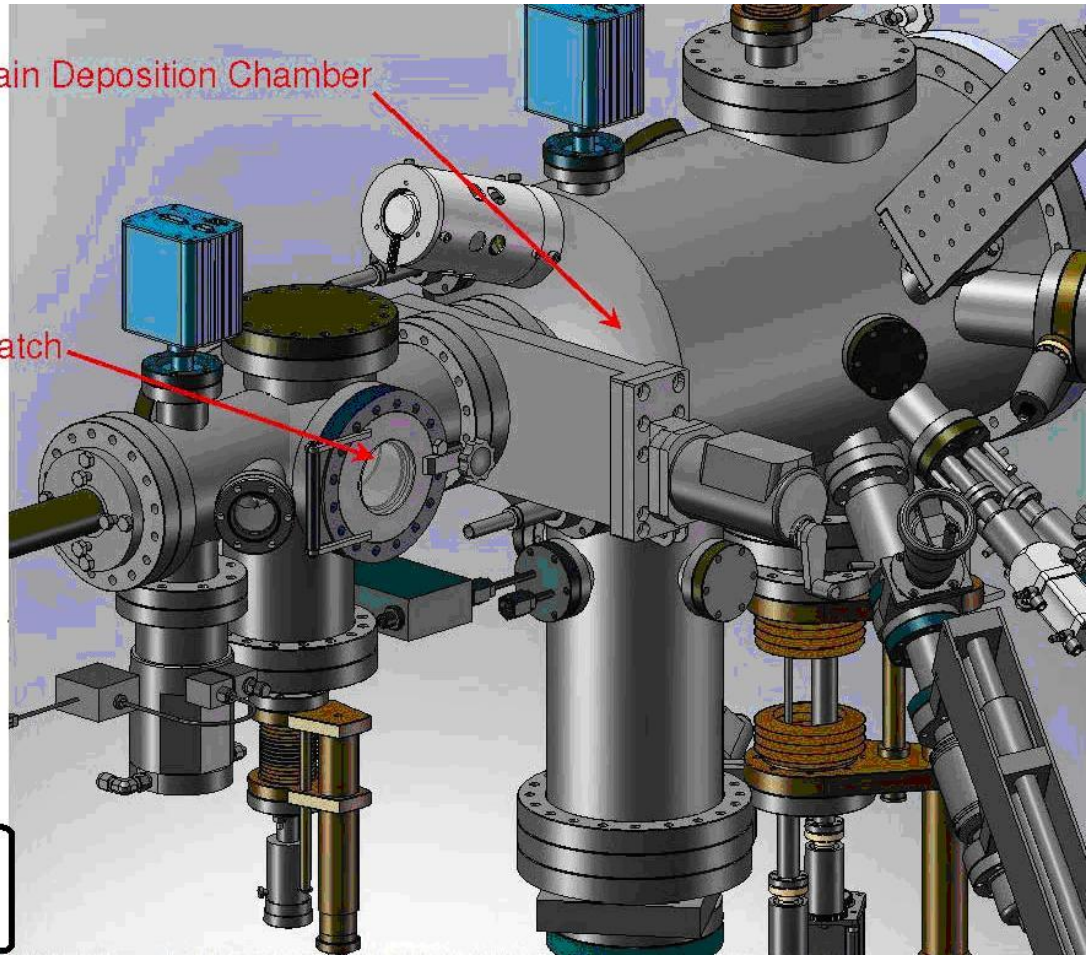




- High-power laser pulses are used to evaporate matter from a target surface
- The plume expands away from the target and condense on the substrate
- The ablation process takes place in a vacuum or UHV chamber.

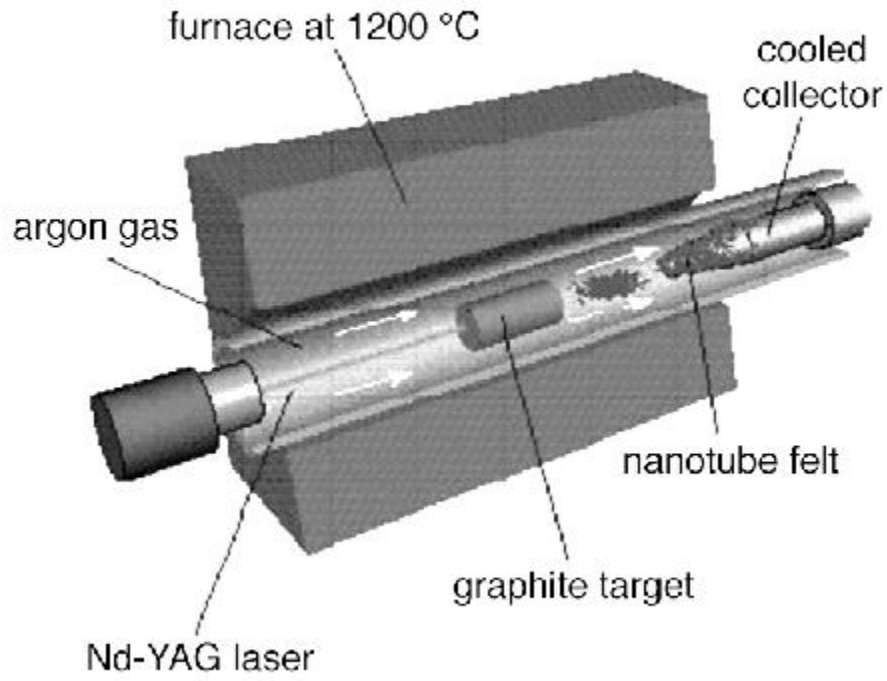
About CSSNT Lab:

Laser ablation HV and UHV chamber



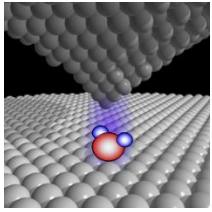
About CSSNT Lab:

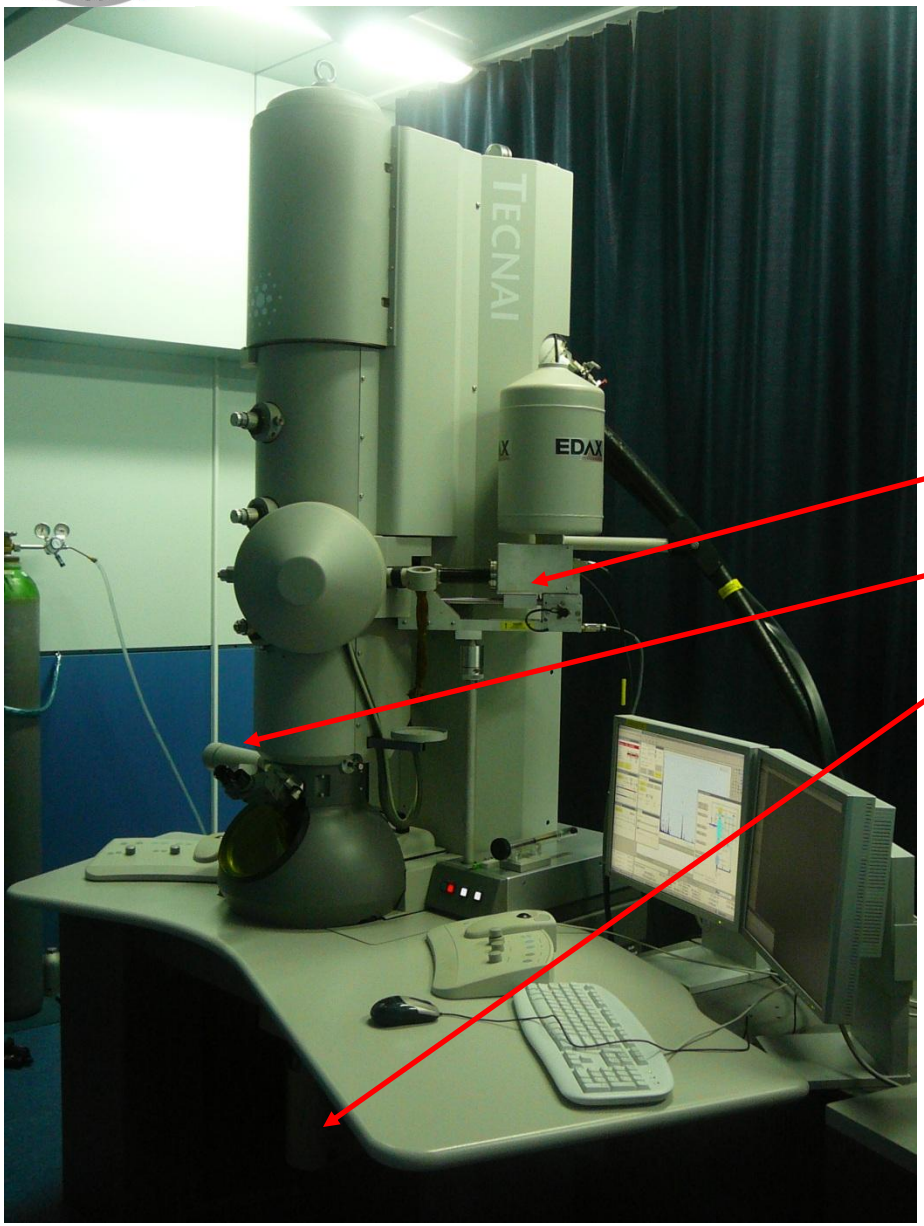
Carbon Nanotube Deposition



- A pulsed laser vaporizes a graphite target in a high-temperature reactor while an inert gas is bled into the chamber
- Nanotubes develop on the cooler surfaces of the reactor as the vaporized carbon condenses.
- Yields around 70% and produces primarily **single-walled carbon nanotubes** with a controllable diameter determined by the reaction temperature

About CSSNT Lab:





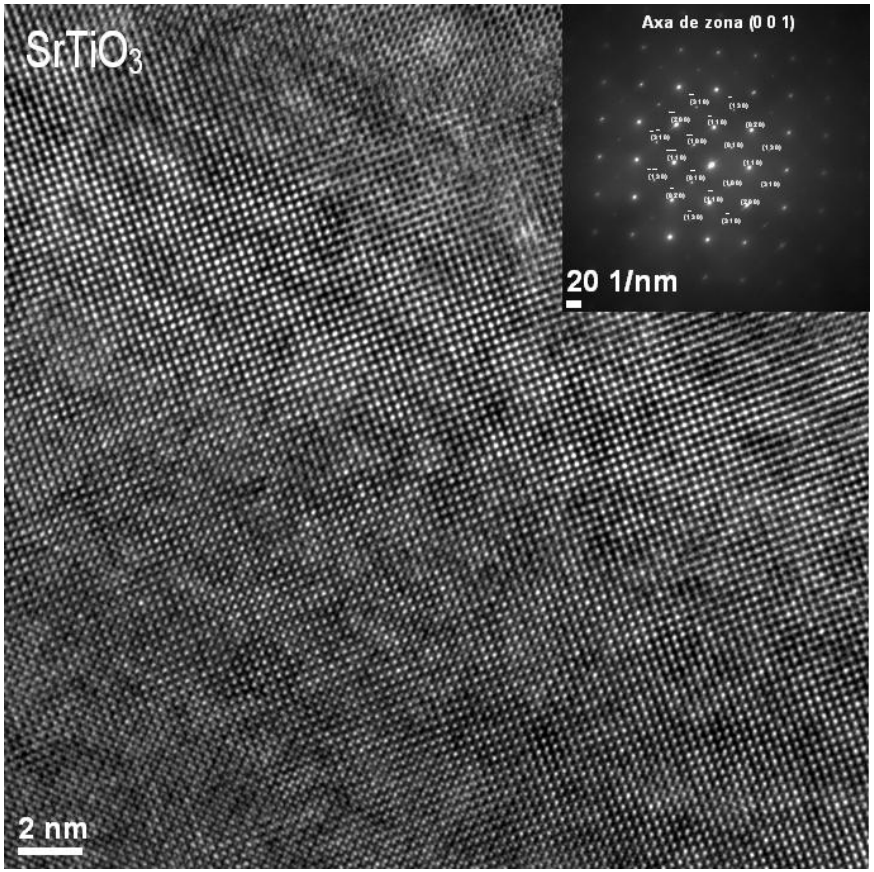
TEM

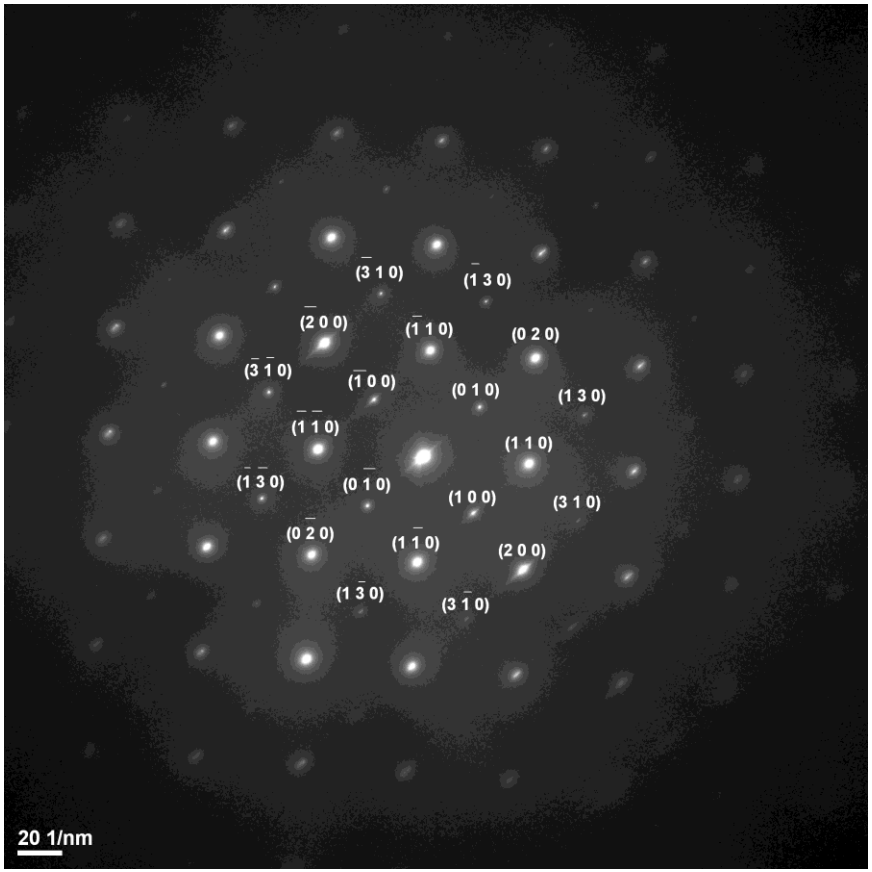
Transmission Electron Microscope Tecnai™ G² F30 S-TWIN:

- **Energy-dispersive X-ray spectroscopy - EDX;**
- **Detector STEM/HAADF(high angle annular dark field);**
- **Electron energy loss spectroscopy EELS – GATAN Tridiem 2001 (EFTEM-EELS);**
- **HRTEM linear resolution: 1.02 Å;**
- **HRTEM punctual resolution: 2 Å;**
- **Rezoluţie STEM-HAADF: 1.9 Å;**

About CSSNT Lab:

TEM





TEM image and electron diffraction image on $SrTiO_3$ crystal

About CSSNT Lab:

SEM

Scanning Electron Microscope

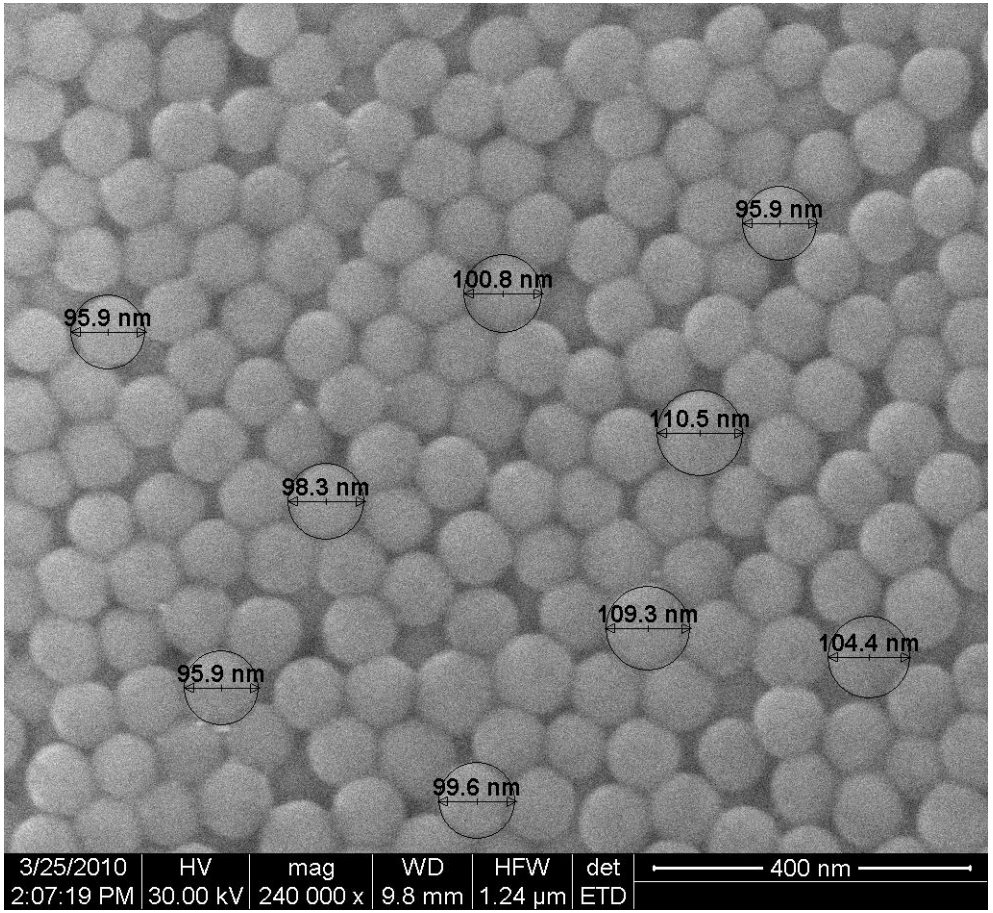
Quanta Inspect F:

- **Energy-dispersive X-ray spectroscopy - EDX;**
- **Resolution: 1.2 nm;**

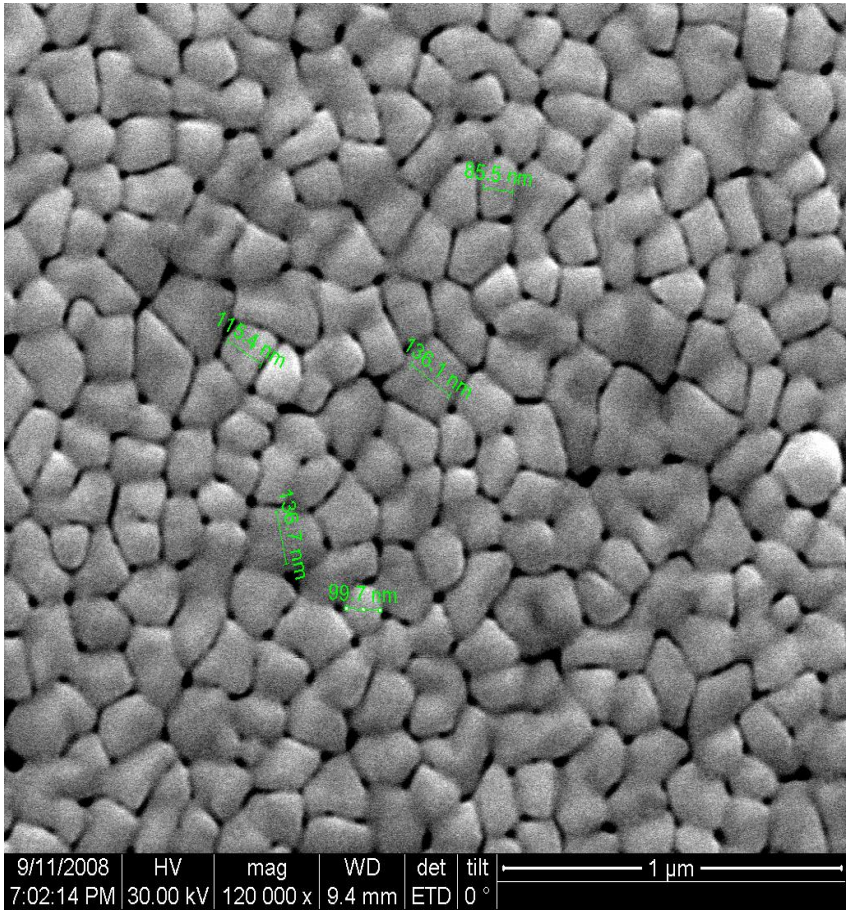
About CSSNT Lab:

SEM

Latex

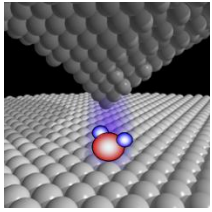


PZT Thin Film



EuroNanoMed

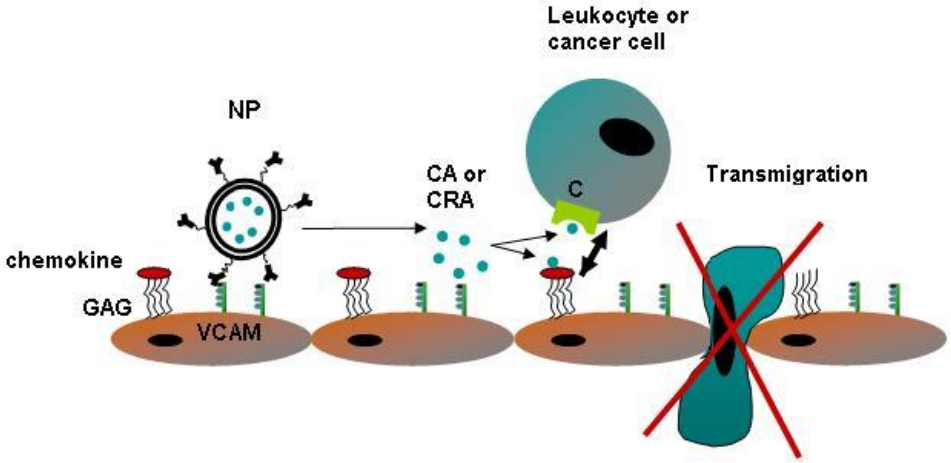
June 2010

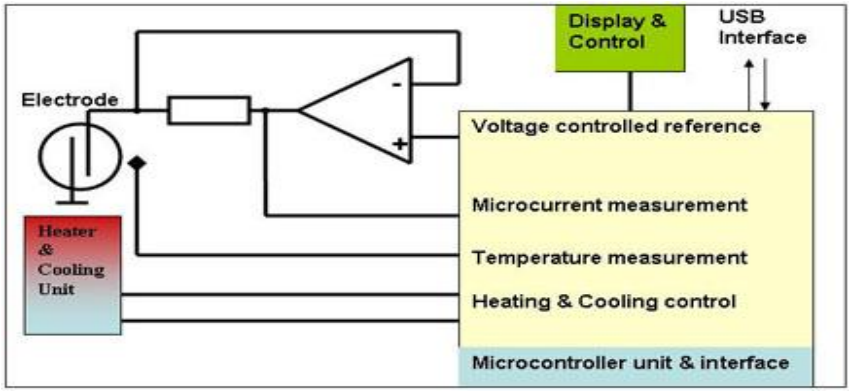


NANODIATER - project

"Nanoparticles designed to target chemokine-related inflammatory processes in vascular diseases and cancer metastasis and implementation of a biosensor to diagnose these disorders"

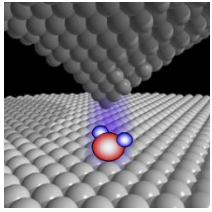
The objectives of NANODIATER are: **1.** to target specially designed nanoparticles (NP) carrying chemokines inhibitors that will be released restrictively at sites of activated endothelium in atherosclerotic plaque formation and tumour cell metastasis and **2.** to design and develop a NP-derived diagnostic kit ("cell sensor") for non-invasive detection of blood circulating inflammatory cells or metastatic tumour cells that can predict the evolution of these diseases.





Working hypothesis: Specifically designed nanoparticles (NP) carrying chemokine antagonists (CA) or chemokine receptor antagonists (CRA) will bind to a particular target molecule expressed by the activated endothelial surface (i.e. VCAM-1), release the CA or CRA, that will block the interaction chemokine/chemokine receptors; this will lead to an inhibition of transmigration of leukocytes (in atherosclerosis) or of tumour metastatic cells (in cancer).

CSSNT is interested in contributing to WG1, WG3, and WG5



Within the frame of COST Action TD 1002

WG1: ***High-resolution AFM of biological systems from molecule to cells***

CSSNT is well positioned for high-resolution AFM and SPFM measurements, already proven, as well as equipment developments

WG3: ***NanoMedicine Nanodiagnosis Nanosensing***

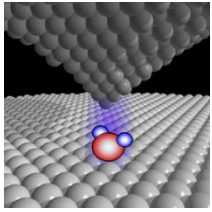
Applied WG that uses AFM with additional techniques: fluorescence, Raman, ion measurements…

CSSNT is well positioned for additional techniques with Raman microscopy and Confocal Fluorescence microscopy recently installed in our lab!

WG5: ***New Instrumentation and Techniques***

Special WG in relation with manufacturers concerning the specifications of standardized AFM Machines for clinical applications.

CSSNT has experience in AFM machine design and implementation and can directly contribute to specs or even developments of the clinical applications machines.



Thank you for your attention!

marius.enachescu@upb.ro or enachescu2007@gmail.com