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

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!
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
SrTiO₃-sample

Radius of Curvature: \( R \approx 160 \, \text{nm} (k=88 \, \text{N/m}) \)

\( \Theta(103)=12.5 \, \text{degree} \)

\( \Theta(101)=14.0 \, \text{degree} \)

atomically flat sloped facets

Radius of Curvature: \( R \approx 110 \, \text{nm} (k=0.23 \, \text{N/m}) \)
About CSSNT Lab:

Scanning Polarization Force Microscopy (SPFM)
When $\varepsilon \gg 1$, $F$ is insensitive to $\varepsilon$.

Dielectric Spectroscopy
Freq. Dependence of $\varepsilon(\omega)$

$\omega_{res} \gg \gg$ topography
$\omega \gg \gg$ contact potential
$2\omega \gg \gg \varepsilon$ mapping

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

$F_{pol} \approx \frac{\varepsilon_i - \varepsilon_0}{\varepsilon_i + \varepsilon_0}$
About CSSNT Lab:

“TOUCHING” Liquid Surfaces - Glycerol

Results of SPFM-DC implemented technique

18.7 μm x 18.7 μm

9 μm x 9 μm
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*
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 Tecnaï™ 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;
• Rezoluție 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
“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!

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