Doctorate in Nanotechnology, University of Trieste
Course "Microscopies for Nanotechnology" (24 hours)

PART_1
Advanced optical microscopy for nanostructure characterization *(6 hours)*

Dan Cojoc, IOM CNR, Laboratorio TASC

The spatial resolution in optical microscopy is known to be diffraction limited to about 200 nm (lateral resolution) and 500 nm (axial resolution). Nevertheless, some new techniques have been proposed in far field optical microscopy to increase by an order of magnitude the spatial resolution. Three techniques will be discussed in this regard: digital-holographic microscopy (DHM), Forster Resonance Energy Transfer microscopy (FRET) and STimulated Emission Depletion microscopy (STED). DHM is an interferometric based technique allowing to obtain nm axial resolution for unstained samples, observed in bright field. FRET and STED are fluorescence based techniques based on non-radiative resonant energy transfer (FRET) and fluorescence depletion by means of stimulated emission (STED) allowing to obtain 10-20 nm lateral resolution and about 50 nm axial resolution. The explanation of the techniques will be followed by examples of applications for nanostructure characterization, with a focus on live cell nano-biology.
Finally, the use of optical sample manipulation in X-ray microscopy and diffraction experiments with Synchroton Light and Free Electron Laser Beam will be discussed.

PART_2
Advanced Imaging and Spectromicroscopy methods for chemical and structural characterization of micro- and nano-materials *(6 hours)*

Maya Kiskinova, Elettra Sincrotrone Trieste

The goal is to provide basic knowledge for the most advanced synchrotron-based methods for 'nano-research' such as complementary chemical-structural imaging, micro- spectroscopy, coherent diffraction imaging of individual nano-structures ranging from inorganic to organic and bio-materials.
The course will cover the following topics:

1. Principle approaches for spatially resolved imaging and spectroscopy using photon sources: contrast mechanisms and spectroscopies for probing at different depth scales. It will include: concepts for realization lateral resolution, contrast mechanisms based on x-ray interaction with matter and brief overview of all related imaging and spectroscopic methods.
2. Photoelectron spectro-microscopy and imaging using photon microprobe: instrumentation, methodology and applications.
3. Transmission/emission microscopy in scanning and full-field imaging mode: absorption, phase and chemical imaging.
4. Coherent diffraction imaging using synchrotrons and FELs.

PART_3
Scanning probe microscopies *(6 hours)*

Cristina Africh, IOM CNR, Laboratorio TASC 

1. Scanning tunneling microscopy
    1.1Imaging
    1.2Spectroscopy
    1.3Manipulation
2. Other SPMs and their application to Nanotechnology.

PART_4
Infrared microscopy *(6 hours)*

Elisa Vaccari, Elettra Sincrotrone Trieste 

1. The infrared spectral region
2. Basics on vibrational spectroscopy
3. Instrumentation
    3.1 FTIR interferometer
    3.2 Vis-IR microscope
4. InfraRed Synchrotron Radiation (IRSR)
    4.1 Infrared Synchrotron Radiation sources
    4.2 IRSR Advantages
    4.3 IR Beamline design
5. SR-IRMS applications in the MIR domain
    5.1 Biological applications of SR FTIR microspectroscopy
6. Limitations of far-field FTIR microscopy: new prespectives