UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Materials Spectroscopy and Microscopy

2526-1-F1702Q011

Aims

The scope of the course is to give the students a general introduction to the main spectroscopy and imagine techniques currently available for material characterization, with a focus on materials with applications in optometry and vision science.

Contents

The course will be divided in three sections:
1 – A general introduction, with basic concept of light interaction with matter;
2 – Spectroscopy techniques: UV-VIS, IR/FTIR, Raman, Ellipsometry, X-ray based spectroscopies, synchrotron light techniques;
3 – Imaging techniques: standard and superresolution (STED, PALM, STORM) microscopies, SEM/TEM, STM, AFM.
Both spectroscopy and imaging modules will be complemented by a lecture about the corresponding basic data analysis methods.

Detailed program

• Introduction: complex analysis reminders (Fourier transform); fundamental models for light-matter interaction: reflectivity index, Lorentz oscillator model for single resonator, TART diagrams, double level transition time and linewidth.

• Spectroscopy techniques. Experimental setup, methods and application examples with special focus on the materials for optics, optometry, and vision science:

o UV-VIS spectroscopy;
o Raman and IR/FTIR spectroscopy: vibrational modes, methods and application examples;
o Ellipsometry: introduction, experimental setup, material modelling and application examples;
o General introduction to X-rays; overview of X-ray spectroscopies (XRD, XPS, XAS).
o Data analysis methods for spectroscopy data: smoothing, interpolation, convolution/deconvolution filters, noise estimation, spectra matching, curve fitting, data visualization best practice.

• Imaging technique: experimental setup, methods and application with special focus on the materials for optics, optometry, and vision science:
o Overview of microscopy: experimental setup, general concepts;
o Fluorescence microscopies and superresolution techniques (STED/PALM/STORM/SNOM)
o Electron microscopies: SEM and TEM. Experimental setup and sample preparation;
o Rasterization techniques: scanning tunneling microscopy and atomic force microscopy.
o Data analysis methods for imaging results: morphological transformations, convolution operators, FFT filtering, contours detection and cluster identification, general statistics evaluation, data visualization guidelines.

Prerequisites

Student requirements match the topics listed in the “Orienteering for Future Students and Admission Procedures”, available on the e-learning platform.

Teaching form

42 total lecture time:
• 26 hours of frontal lectures;
• 4 hours of interactive frontal lessons
• 12 hours of remote lectures, recorded

Textbook and teaching resource

Course slides, vide recordings for remote lessons, additional material provided by the teacher.

Semester

second semester

Assessment method

Oral examination, consisting of a set of al least three questions on the course topics to test the knowledge of the student and his/her capability of applying the course contents to simple case studies.

Each student will, in accordance to the teacher, choose a topic or a technique for an in-depth analysis, whose presentation will determine 2/3 of the final outcome.
There is no mid-term evaluation.
Grading policy: insufficient: less than18; sufficient: 18-23; good: 24-27; very good: 28-30; excellent: 30 cum laude.

Office hours

by appointment to be arranged via email

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE