Course Specifications
Valid as from the academic year 2020-2021

Analytical Methods for Material Characterization (C004155)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size (nominal values; actual values may depend on programme)

Credits 9.0  Study time 270 h  Contact hrs 67.5 h

Course offerings and teaching methods in academic year 2020-2021

A (semester 1)  English  Gent  online lecture 0.0 h
lecture 50.0 h

Lecturers in academic year 2020-2021

Adriaens, Mieke  WE06  lecturer-in-charge
Dendooven, Jolien  WE04  co-lecturer
Vanhaecke, Frank  WE06  co-lecturer
Vincze, Laszlo  WE06  co-lecturer

Offered in the following programmes in 2020-2021

Master of Science in Teaching in Science and Technology (main subject Chemistry)  9  A
Master of Science in Chemistry (main subject Analytical and Environmental Chemistry)  9  A
Exchange Programme in Chemistry (master's level)  9  A

Teaching languages

English

Keywords

Chemical analysis, surfaces, nanomaterials, electron interaction, photon interaction including synchrotron radiation, ion interaction, local probe methods and inductively coupled plasma mass spectrometry.

Position of the course

This course discusses analytical methods which help us to chemically characterize material. It aims at understanding the principles of these techniques together with their capacities in various types of applications.

Contents

1. General introduction to the characterisation of material
2. Methods based on electron interaction
   • Interaction of electrons with matter
   • Overview of techniques based on electron interaction
   • Transmission electron microscopy (TEM) and electron energy loss spectroscopy (EELS)
   • Scanning electron microscopy (SEM, SEM-EDS, SEM-WDS)
   • Auger electron spectroscopy (AES, SAM)
3. Methods based on ion interaction
   • Interactions of ions with matter
   • Overview of techniques based on ion interaction
   • Secondary ion mass spectrometry (SIMS)
   • Rutherford backscattering (RBS)
   • Particle Induced X-ray Emission (PIXE)
4. Methods based on photon interaction
   • Interaction of photons with matter
   • Overview of techniques based on photon interaction
   • X-ray photoelectron spectroscopy (XPS)
   • Properties of conventional X-ray and synchrotron radiation (SR) sources
   • Quantitative methods in (SR)XRF analysis

(Approved)
• X-ray Absorption Near Edge Structure (XANES) spectroscopy
• Extended X-ray Absorption Fine Structure (EXAFS) spectroscopy
• Scanning X-ray micro- and nano-analysis using synchrotron radiation
• X-ray fluorescence microtomography
• Confocal X-ray fluorescence imaging
5. Local probe methods
• Principle
• Scanning probe microscopy (SMP)
• Scanning force microscopy (SFM)
• Scanning tunneling microscopy (STM)
• Atomic force microscopy (AFM)
6. Inductively coupled plasma mass spectrometry
• Introduction to the basic operation principles of the quadrupole filter, sector-field mass spectrometer and time-of-flight analyzer
• Basic operation principles of ICP-mass spectrometry (ICP-MS)
• Figures of merit of ICP-MS
• Spectral interferences
• Resolution of spectral interferences (physical & chemical resolution)
• Non-spectral interferences
• Calibration approaches (including isotope dilution)
• Alternative sample introduction approaches (including aerosol desolvation, electrothermal vaporization, laser ablation)
• Advanced ICP-MS applications
• Ultra-trace elemental analysis
• Multi-collector ICP-mass spectrometry (including a comparison with thermal ionization mass spectrometry – TIMS)

Initial competences
Having followed the courses Physics, Analytical chemistry and Spectroscopic methods of analysis or having mastered the corresponding competences in another way.

Final competences
1. The student has an overview of methods for the chemical characterization of materials including nanomaterials and surfaces, their application area, capabilities and limitations.
2. The student is aware of and can explain the basic operating principles of analytical instrumentation in the field of study.
3. The student is capable of suggesting and appropriate analytical technique for a given chemical problem in this context.

Conditions for credit contract
Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract
This course unit cannot be taken via an exam contract

Teaching methods
Lecture, online lecture

Extra information on the teaching methods
Due to COVID19 alternate teaching methods may be implemented should these prove necessary.

Learning materials and price
• English lecture notes
• Estimated cost: 20 Euro

References

Course content-related study coaching
• Through individual feedback by lecturer
• Answering of questions after the lectures, via e-mail or during a personal meeting (appointment made via e-mail).

Evaluation methods

Examination methods in case of periodic evaluation during the first examination period
Written examination with open questions, written examination with multiple choice questions

Examination methods in case of periodic evaluation during the second examination period

(Approved)
Written examination with open questions, written examination with multiple choice questions

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation
not applicable

Extra information on the examination methods
Written examination. The examination consists of overview questions, more detailed questions on specific course subjects and questions aiming at assessing the student’s understanding of the matter. Evaluate the understanding of basic concepts and being able to apply them in concrete problem cases. Exercises are also included in the theoretical exam.

Calculation of the examination mark
Written exam: 100%