Course Specifications
Valid as from the academic year 2015-2016

Mass Spectrometry & Isotopic Analysis (C002564)

Course offers and teaching methods in academic year 2017-2018

A (semester 2)

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<th>Language</th>
<th>Seminar</th>
<th>Lecture</th>
<th>Practicum</th>
<th>Self-reliant Study</th>
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<td>English</td>
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Lecturers in academic year 2017-2018

- Vanhaecke, Frank (WE06; lecturer-in-charge)
- Boeckx, Pascal (LA24; co-lecturer)

Offered in the following programmes in 2017-2018

- Master of Science in Chemistry: 6 crdts
- Master of Science in Chemical Engineering: 6 crdts
- Exchange Programme in Chemistry (master's level): 6 crdts

Teaching languages

- English

Keywords

- Mass spectrometry, isotope ratios

Position of the course

In this course, the students first obtain insight into the sources of natural variation in the isotopic composition of the elements. Subsequently, they are familiarized with the basic principles of the most important types of mass spectrometers and their use in instruments deployed in the context isotopic analysis. The capabilities offered by isotopic analysis are illustrated via real-life application from various research fields. This course aims at providing the student with a quite profound insight into the techniques that are deployed in the context described above, their application areas and the capabilities and limitations of up-to-date instrumentation.

Contents

- An introduction to inorganic mass spectrometry / definition of terms
- Types of mass spectrometers (sector field, quadrupole-based, time-of-flight)
- The isotopic composition of the elements
- Natural abundance, fractionation and notation for light stable isotopes
- ICP - mass spectrometry (ICP-MS)
- Thermal ionization mass spectrometry (TIMS)
- Multi-collector ICP - mass spectrometry (MC-ICP-MS)
- Accelerator mass spectrometry (AMS, for 14C-dating & other applications)
- Principles of measurement of light stable isotopes via isotope ratio mass spectrometry (IRMS)
- Compound-specific stable isotope analyses via GC and HPLC-IRMS
- Laser-based spectroscopy for light element stable isotope analysis
- Isotope ratio applications: Sr, Pb, nuclear applications, stable isotopic tracer experiments, applications based on natural isotope fractionation effects, source identification and biodegradation of pollutants (e.g., nitrate and BTEX), greenhouse gas emission and source apportionment (nitrate, greenhouse gases), 15N tracing studies for N biogeochemistry, stable isotope probing and use of biomarkers (e.g., microbial community structures, soil C dynamics and paleo-climatology)

(Approved)
Initial competences

Successful completion of the courses ‘Analytical chemistry: principles’ and
‘Spectroscopic methods of analysis’ or having mastered the corresponding
competences in another way.

Final competences

1. Insight into the causes of natural variation in the isotopic composition of the
   elements.
2. Having an overview over the mass spectrometric methods that can be deployed for
   isotopic analysis, their application areas, capabilities and limitations.
3. Understanding and being able to explain the basic operating principles of analytical
   instrumentation for isotopic analysis.
4. Selecting an appropriate mass spectrometric technique for isotopic analysis for an
   analytical problem in this context.
5. Awareness of applications relying on isotopic analysis, including elemental assay via
   isotope dilution, dating, provenance determination, isotope ratios as paleoproxies
   and biomarkers, environmental studies.
6. Adequately interpreting a paper on isotopic analysis from the international literature.
7. Solving problems in the context of isotopic analysis via mass spectrometric
   techniques.

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, practicum, self-reliant study activities, seminar: coached exercises.

Extra information on the teaching methods

Assignment – the student selects a paper out of a selection of publications from
international peer-reviewed journals, assesses which technique was used, what the
purpose of the investigation was, how the measurements were carried out, etc and
communicates this to his/her fellow students via an oral presentation.

Learning materials and price

Syllabus in English. Estimated cost: 20.0 €.

References

1. Inorganic Mass Spectrometry - Fundamentals and Applications, eds: C.M. Barshick,
   D.C. Duckworth and D.H. Smith, Marcel Dekker, 2000 (ISBN 0824702433)
   (ISBN 1405109165)
3. Modern Isotope Ratio Mass Spectrometry, ed. I.T. Platzner, John Wiley & Sons,
   1997 (ISBN 0471974161)
4. Isotopic analysis - fundamentals and applications using ICP-MS, F. Vanhaecke and

Course content-related study coaching

Answering of questions via e-mail or during a personal meeting after appointment,
made by e-mail.

Evaluation methods

end-of-term evaluation and continuous assessment.

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

Written examination with open questions, oral examination.

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

Written examination with open questions.

Examination methods in case of permanent evaluation

Assignment

Possibilities of retake in case of permanent evaluation

not applicable

(Approved)
Extra information on the examination methods

Theory:
Written examination with oral explanation.
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. Exercises are also included in the theoretical exam.
Permanent evaluation via an assignment – the student studies a relevant publication from an international peer-reviewed journal, assesses which technique was used, what the purpose of the investigation was, how the measurements were carried out, etc and communicates this to his/her fellow students via an oral presentation. Students who are absent without any well-justified reason or who do not participate in all evaluation methods (practicals) of the continuous assessment, get a non-deliberable examination mark. The quotation for the non-periodical evaluation is transferred to the second examination period, which consists of a periodical examination only.

Calculation of the examination mark

Theory: 100% periodical evaluation
Exercises: Partly based on permanent evaluation (cf. the assignment mentioned above). The permanent evaluation accounts for 25% of the final mark.
Students who are absent without any well-justified reason or who do not participate in (part of) the permanent evaluation, do not pass the exam for this course unit.
The marks resulting from the permanent evaluation are retained in the second examination period, as the second examination period only consists of a periodical evaluation.