



Electron Microscopy, Crystallography



Niveau d'étude
BAC +5



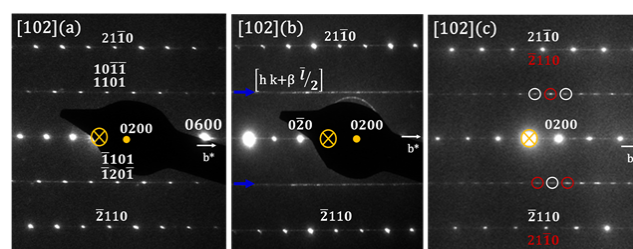
ECTS
6 crédits



Composante
Faculté des
Sciences

En bref

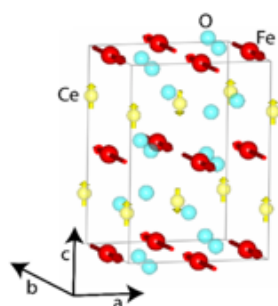
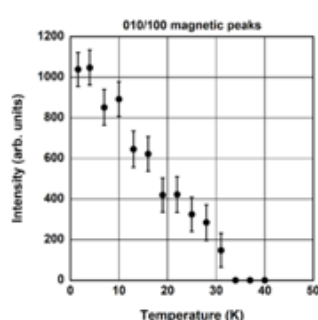
- **Date de début des cours:** 1 sept. 2021
- **Langue(s) d'enseignement:** Anglais
- **Méthode d'enseignement:** En présence
- **Organisation de l'enseignement:** Formation initiale
- **Ouvert aux étudiants en échange:** Non



The structural characterization of Materials is a mandatory prerequisite to develop functional materials and an absolute must for materials science researchers and engineers. For the interpretation of diffraction patterns, structures, microstructures etc., a detailed knowledge in crystallography, structure analysis but equally of the instruments used is necessary. The necessary knowledge is developed from the scratch, progressively yielding an understanding on how to characterize materials by standard and sophisticated diffraction methods. The lecture also includes lab work on powder and single crystal diffractometers, allowing to acquire the competencies to correctly use and interpret diffraction data. The lecture during the 1st semester involves essentially X-ray diffraction as well as electron microscopy, while the crystallography part continues during the 2nd semester with symmetry, structure solution and structure refinements as well as neutron scattering and magnetic structure analysis.

Présentation

Description



This lecture contains 2 parts:

(1): Crystallography:

This part is essentially dedicated to get familiarized with structure analysis and its application. After a brief introduction of the reciprocal lattice concept and the use of space groups in crystallography, the lecture focusses on structure analysis

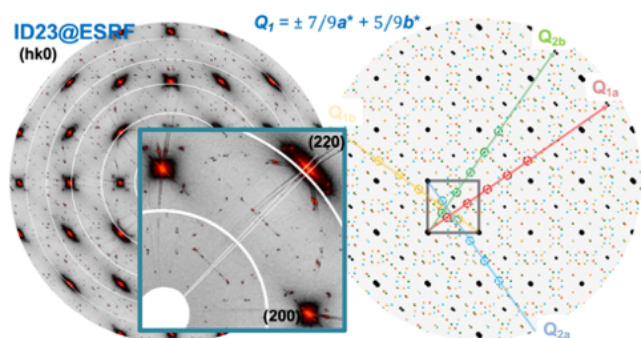


by diffraction methods using powder and single crystal X-ray and neutron scattering methods. This concerns an understanding into related techniques, i.e. the use of powder and single crystal diffractometers, as well the techniques and programs used today for structure refinements. The concept of the lecture is to introduce into a basic understanding of what is behind the programs, rather than to use them blindly. Students will also collect single crystal diffraction data on a performant 4 cycle diffractometer with a 2D area detector, as well as magnetic structure analysis using neutron diffraction methods.

Simple inorganic structures: Space groups, X-ray/neutron and synchrotron sources, interaction of X-rays, electrons and neutrons with matter, reciprocal lattice, concept of Ewald sphere, powder diffractometers, single crystal diffractometers, orienting matrix, Patterson method, structure refinement from powder or single crystal data, magnetic structure analysis, magnetic space groups,

(2): Electron microscopy:

In this part, we will be interested in electron microscopy through flipped classes. We will discuss the following topics: Electron sources, lens and aberrations, sample preparation, electron diffraction, Structural and chemical analysis, Imaging techniques.



Volumes horaires* :

CM : 33 h

TD : 18 h

Objectifs

Introduction into structural characterization of condensed matter by diffraction methods at different correlation lengths.

The objectives of the transmission electron microscopy part is to give solid knowledge in electron microscopy in order to be able to use appropriate methods for the characterization of materials. The expected skills for this part are knowing in detail the principles of an electron microscope (scanning and transmitted beam) and to be able to describe and schematize the device and its specificities.

Students will get familiarized with diffraction methods and structure refinement methods from powder and single crystal diffraction data, which are analyzed by hand as well by using state of the art programs.

The use of the flipped class promotes student engagement and investment. This way of working is interesting to take possession of the knowledge and pass it on to the class.

Contrôle des connaissances

CC intégral

Syllabus

Crystallography:

- Brief revision of symmetry and space groups
- Introduction into structure refinement (single crystal and powder methods)
- Magnetic structures with neutron diffraction
- Structure determination from single crystals (experiment and theory)



- Structure determination from powder diffraction data (experiment and theory)
- The applications of Fourier series for structure solution and refinements: from the Patterson Method to difference Fourier analysis
- Phase transitions, crystal twinning and related changes of the direct and reciprocal lattice
- Contrast variation and anomalous scattering together with absolute structure determination
- Electron microscopy:
- In this part, we will be interested in electron microscopy through flipped classes. We will discuss the following topics: Electron diffraction, diffraction pattern, Electron sources, lens and aberrations, sample preparation, electron diffraction, Structural and chemical analysis, Imaging techniques.

Informations complémentaires

Contact(s) administratif(s) :

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Bibliographie

- * Transmission Electron Microscopy, A text book for materials Science, Davis B. Williams, C. Barry Carter
- * Physical Principles of Electron Microscopy, Ray F. Egerton, Springer
- * and C. McKie: Essentials of Crystallography, Blackwell Scientific Publications
- * Borchardt-Ott: Crystallography: an introduction, Springer
- * Als-Nielsen, D. McMorrow: Elements of Modern X-ray Physics
- * Massa: Crystal Structure Determination, Springer
- * Stout-Jensen: X-ray Structure Determination, Academic Press
- * L. Squires : Introduction to the theory of thermal neutron scattering, Oxford, Cambridge University press

- * Neutron and Synchrotron Radiation for Condensed Matter Studies Part I and II, Springer, Editors: Baruchel, J., Hodeau, J.-L., Lehmann, M.S., Regnard, J.-R., Schlenker, C. (Eds.)

Infos pratiques

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Lieu(x)

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