MSE-306

Crystalline materials: structures and properties

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Cursus	Sem.	Type
Materials Science and Engineering	BA6	Obl.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	**5 weekly**
Lecture	3 weekly
Exercises	2 weekly
Number of positions	

Summary

The properties of crystals and polycrystalline (ceramic) materials including electrical, thermal and electromechanical phenomena are studied in connection with structures, point defects and phase relations. The students learn how to analyse/predict properties based on structure, symmetry and defects

Content

1. Basic crystalline structures of important materials. Description of symmetry.
2. Use of tensors for description and analysis of anysotropics properties of solids
3. Point defects and their relationship to functional properties.
4. Dielectric, mechanical, and thermal properties of crystalline materials
5. Cross-coupled electro-mechanical and thermo-electro-mechanical properties
6. Electronic and ionic conductivity in functional materials (dielectrics, piezoelectrics, and ferroelectrics) and various applications
7. Phase transitions and application-relevant properties of crystalline materials
8. Making use of suitable instruments and techniques for dielectric, transport and electromechanic measurements, analysis and interpretation of experimental results

Keywords

crystal structure; ceramics; point defects; phase equilibria; phase transitions; point groups; conductivity; tensors; semiconductor; elesticity; dielectric; piezoelectric; electrocaloric; ferroelectric; electro-mechanical; transport properties; electrical charaterization

Learning Prerequisites

Required courses

General physics; General inorganic chemistry; Mathematical analysis; Introduction to materials;

Important concepts to start the course

chemical bonds; phase transitions; atomic and electronic structure of materials; thermodynamics; microstructure of materials; symmetry of materials; electrostatics

Learning Outcomes

By the end of the course, the student must be able to:

- Predict functional properties of crystalline solids based on their structure
- Analyze anisotropic electrical, mechanical, thermal and cross-coupled thermo-electro-mechanical properties
- Apply the acquired knowledge for development of functional materials
- Select appropriately suitable materials for devices and functional elements with pre-determined characteristics
- Characterize crystalline and ceramic materials and evaluate their potential for various applications
- Design functional elements based on acquired knowledge on electroceramics

Transversal skills

- Use a work methodology appropriate to the task.
- Use both general and domain specific IT resources and tools
- Collect data.

Teaching methods

Lectures in class (3 h); exercises, discussions and practical demonstrations (2 h)

Expected student activities

Attendance of lectures, doing exercises during class and at home, reading written material, discussion in class, reading and analyzing supplemental materials (journal papers and scientific communications)

Assessment methods

The final grade is attributed based on the grade of the final written exam (5/6) and written test during the semester (1/6)

Supervision

Office hours	Yes
Assistants	No
Forum	No

Resources

Bibliography

Moulson and Herbert: Electroceramics, Wiley, NY
Newnham: Properties of Materials: Anisotropy, Symmetry, Structure; Oxford University, Oxford

Ressources en bibliothèque

- Newnham: Properties of Materials: Anisotropy, Symmetry, Structure; Oxford University, Oxford
- Moulson and Herbert: Electroceramics, Wiley, NY

Moodle Link

- https://go.epfl.ch/MSE-306