MSE-480 **Dielectric properties of materials**

Damjanovic Dragan

Cursus	Sem.	Type
Materials Science and Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	2
Session	Summer
Semester	Spring
Exam	Written
Workload	60h
Weeks	14
Hours	**2 weekly**
Courses	2 weekly
Number of positions	

Summary

Students learn about response of electrically insulating materials to electrical and mechanical fields. The emphasis is on effect of various types of defects on properties, on crystal structure/microstructure - property relations, and on ways how to engineer properties of materials for applications.

Content

Dielectric polarization. Dielectric relaxation in ceramics and polymers. Dielectric loss. Nonlinear dielectric properties. Hysteresis. Dielectric spectroscopy. Capacitors and insulators. Dielectric breakdown. Aging. Insulating materials for electronic packaging.
Piezoelectric effect. Polar dielectrics. Coupling of thermal, mechanical and electrical properties. Electrostriction. Ferroelectricity. Ferroelectric and ferroelastic domains. Piezoelectric ceramics and polymers. Composite materials. Piezoelectric resonance. Applications of piezoelectric materials: actuators, sensors and ultrasonic transducers. Medical application of piezoelectric materials. Environmentally friendly piezoelectric material; biocompatibility and functional materials.
Selected topics in multiferroic materials.
Pyroelectricity and pyroelectric materials and devices.
Thermistors. PTC and NTC effects.

Keywords

dielectrics; ceramics; single crystals; electrical conductivity; dielectric relaxation; piezoelectricity; ferroelectricity, capacitors; thermistors; actuators; sensors; resonators; composites; multiferroics;

Learning Prerequisites

Required courses

General physics;
General inorganic chemsitry;
Mathematical analysis:
Introduction to materials;
Thermodynamics;

Recommended courses

Chrystallography and diffraction metods;
Theory of materials: from structure to properties I

Important concepts to start the course

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

Learning Outcomes

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

- Interpret given experimental behavior of materials in terms of physical processes learned during the course
- Hypothesize how crystal structure, defects structure, microstructure, chemical composition affect properties of materials.
- Argue on advantages and disadvantages of given materials for various applications

Transversal skills

- Take feedback (critique) and respond in an appropriate manner.
- Access and evaluate appropriate sources of information.
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

lectures; discussions;

Expected student activities

attendance of lectures; reading distributed written material; participating in discussions in class;

Assessment methods

Written exam

Supervision

Office hours	Yes
Assistants	No

Resources

Bibliography

Moulson, "Electroceramics", Chapman&Hall 1990
R. E. Newnham, "Properties of Materials: Anisotropy, Symmetry, Structure", Oxford University, 2005.

Ressources en bibliothèque

- Properties of materials : anisotropy, symmetry, structure / Newnham
- Electroceramics / Moulson

Notes/Handbook

Copies of viewgraphs; Written text based on lectures (partial coverage);