PHYS-307

Physics of materials

La Grange Thomas

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course discusses materials physics associated with the mechanical and structural properties of solids, primarily focusing on the physics of dislocation defect dynamics and linking diffusion kinetics to the fundamental physics of phase transformations.

Content

1. Materials, definitions, structure
Binding energy in metals, ceramics and polymers. Crystal structure and amorphous materials. Theory of elasticity: stress and strain fields.
2. Diffusion
Diffusion in alloys. Physical and chemical diffusion.
3. Plastic deformation and dislocations
Phenomenology. Deformation of single crystals. Burgers' vector. Elasticity theory: interactions among dislocations. Creation and annihilation of dislocations.
4. Dislocation dynamics
Friction forces due to the lattice, to point defects and to dislocations. Movement equations. Partial dislocations and stacking faults. Dissociation mechanisms: dislocations in face centred cubic metals.
5. Dislocation kinetics
Thermal activation of plastic deformation. Dislocation climb. Deformation tests.
6. Electron micrsocopy Dislcoation charactization
Electron diffraction, Dynamical Diffraction contrast imaging theory, High resolution Electron microscopy of dislocation structures.
7. Thermodynamics of phase transformations
Thermodynamical principles of phase transformations.Phase diagrams. Alloy solidification. Solid-solid phase transformations.

Keywords

dislocations, deformation, diffusion, elasticity, phase transformations, melting, precipitation crystallography

Learning Prerequisites

Recommended courses

linear algebra I,II
analysis III, IV
physics I,II

Learning Outcomes

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

- Develop the formalism of dislocation theory
- Model the plastic deformation of materials
- Sketch a phase diagram and its thermodynamic basis
- Expound theories and ideas in published journal articles referencing dislocation and phase transformation theories

Transversal skills

- Use a work methodology appropriate to the task.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Make an oral presentation.

Teaching methods

Oral Lectures and exercises in the classroom. Lecture, exercise and reference materials will be made available on a Moodle. A questions and answer forum is also available on the moodle. Additionally, zoom meeting or in-classroom session will be arranged for exam preperation

Expected student activities

There will be 4 Electron microscopy demostrations.

Assessment methods

Oral exam in English

Supervision

Office hours	Yes
Assistant.e.s	No
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

Each lecture has 10-30page writup that will be available in the moodle that expounds on the lecture and has a Biblography in which students can gain further details and deeper explanation of theories presented in the lectures

Notes/Handbook

There is course book written by Thomas LaGrange that dicusses all of the course lectures. Lecture slides and this course book will be made available on course moodle.

Websites

- http://moodle.epfl.ch

Moodle Link

- https://go.epfl.ch/PHYS-307

Prerequisite for

Physics of new materials