GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2019-2020

Physical Materials Science (E066170)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size (nominal values; actual values may depend on programme)

Credits 6.0	Study time 180 h	Contact hrs	60.0 h

Course offerings and teaching methods in academic year 2020-2021

A (semester 2)	English	Gent	seminar: coached exercises	30.0 h
			lecture	30.0 h
B (semester 2)	Dutch		guided self-study	30.0 h
			seminar: coached exercises	30.0 h

Lecturers in academic year 2020-2021

Kestens, Leo	TW08	lecturer-in-charge

Offered in the following programmes in 2020-2021	crdts	offering
Master of Science in Chemical Engineering	6	A
European Master of Science in Nuclear Fusion and Engineering Physics	6	A
European Master of Science in Photonics	6	A
European Master of Science in Nuclear Fusion and Engineering Physics	6	A
Master of Science in Sustainable Materials Engineering	6	A
Master of Science in Materials Engineering	6	A, B
Master of Science in Chemical Engineering	6	A

Teaching languages

Dutch, English

Keywords

Physical materials science, polycrystalline materials, interface migration, deformed state, solid state transformations, recrystallization, grain growth, martensite transformations

Position of the course

To provide basic knowledge and insight in the principles of materials science, discussion of the microstructure of polycrystalline materials and the solid-state transformations by which the microstructures are formed and controlled. Scientific knowledge on the mechanisms that produce different microstructures and the influence thereof on properties.

Contents

1 Crystallography of polycrystaline materials: representation of single orientations, representation of textures, orientation density functions, crystallography of grain boundaries, aspects of crystal and sample symmetry;

2 Interafces: Classification, geometry and energy of interfaces (small vs large angle boundaries, tilt vs twist boundaries, coherent vs incoherent interfaces), surface tension, equilibrium shape of surfaces, presence of a 2nd phase, shape of grains in 2D and 3D, grain-boundary segregation, motion of grain boundaries (driving force and mobility);

3 Precipitation from solid solutions: Review of free-energy composition diagrams (the tangent rule, spinodal points), crystallographic description of precipitation,

precipitation sequence, kinetics of precipitation reactions (initial formation, particle coarsening, precipitation hardening, examples;

4 The deformed state of polycrystalline materials: the stored energy of cold work, cell-forming and non-cell forming metals, strain heterogeneities: deformation and shear bands, transition bands, deformation textures;

5 Recrystalliization and grain growth: release of stored energy during annealing, property changes, recovery mechanisms (subgrain growth, coalescence, polygonization), kinetics of recovery, nucleation mechanisms for recrystallization, kinetics of recrystallization (JMAK theory, experimental validation, effect of strain, temperature, purity and grain size), control of recrystallization temperature and grain size, dynamic recrystallization, normal grain growth (parabolic law of GG), grain growth in the presence of 2nd phase particles (Zener pinning theory), abnormal grain growth (secondary recrystallization, recrystallization and gran growth textures;

6 Order-disorder structures: Study of order-disorder structures in material systems;

7 Martensitic transformations: twinning (phenomenological and crystallographic aspects of deformation and annealing twins), invariant plane strain transformations, crystallography of martensitic (displacive) transformations, characteristics of martensitic transformations (cooperative motion, interface velocity, diffusionless character, morphology, interface structure, kinetics), thermo-elastic martensites, the shape-memory effect, bainite (basic characteristics, crystallography, reaction mechanisms).

Initial competences

"Microstructural configuration of materials (E066020)" or equivalent to be evaluated by Curriculum Committee

Final competences

1. Acquiring knowledge concerning the crystallographic structure and properties of (mechanical) twins.
2. Acquiring physical insight in the structure and properties of interfaces.
3. Being able to establish a link between the typical characteristics of the (sub-) structure of a plastically deformed metal and the properties of the recrystallized structure after recovery annealing.
4. To gain insight in the process of martensitic phase transformation.
5. Mastering the basic concepts of quantitative texture analysis.
6. Gain a deeper insight in the relationship between thermodynamic laws and the formation of microstructures of materials.
7. Control and apply the basic concepts of materials science crystallography.

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

Guided self-study, lecture, seminar: coached exercises

Extra information on the teaching methods

Ex-cathedra lectures added with classroom exercises and homeworks.

Learning materials and price

Powerpoint lecture notes

References

- D.A. Porter and K.E. Easterling: Phase Transformations in Metals and Alloys, Stanley Thornes (Publishers) Ltd, Cheltenham, UK, 2000
- John D. Verhoeven, Fundamentals of Physical Metallurgy, 1975, Wiley, ISBN 0-471-616-6
- F.J. Humphreys and M. Hatherly, Recrystallization and Related Annealing Phenomena, Elsevier, 2004 (2nd edition), ISBN 0 08 044164 5

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

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

Oral examination

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

Oral examination

Examination methods in case of permanent evaluation

Participation, report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible

Extra information on the examination methods

During examination period: oral closed-book exam, written preparation. Theory and applications will be evaluated separately.
During semester: graded exercises of homework assignments.

Calculation of the examination mark

60% of evaluation on knowledge of classroom taught material ("theory") and 40% of evaluation on assignments (exercises). Marks of 1st examination period can be transferred to 2nd examination period.