MSE-422

Advanced metallurgy

Leinenbach Christian

Cursus	Sem.	Type
Materials Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Summary

This course covers the metallurgy, processing and properties of modern high-performance metals and alloys (e.g. advanced steels, Ni-base, Ti-base, High Entropy Alloys etc.). In addition, the principles of computational alloy design as well as approaches for a sustainable metallurgy will be addressed

Content

The course's goal is to enlarge the field of knowledge of the students beyond the classical three metals and alloy classes (i.e. iron and steel, aluminium, copper and their alloys) and to provide a thorough understanding of the processing-microstructure-properties relationship of high-performance alloys. The students will be introduced to modern computer-assisted methods based on thermodynamic and kinetic simulations for the design of multi-component alloys. In addition, the course will address modern metals processing technologies including novel approaches for a sustainable metallurgy.
Course outline:

1. **Repetition**

Thermodynamics of alloys and phase diagrams
kinetics; solid and liquid state phase transformations
mechanical properties (quasistatic, cyclic, creep); strengthening mechanisms in alloys

2. **Modern high performance metallic materials**

Advanced steels (austenitic steels, advanced high-strength steels, TRIP/TWIP steels)
Ni and Co alloys
Al and Mg alloys
Ti alloys
Precious metals (Au, Pt alloys)
Structural intermetallics (TiAl, FeAl)
High entropy alloys and bulk metallic glasses

3. **Introduction into alloy design**

Thermodynamic/kinetic modeling; integrated computational materials engineering
Combinatorial metallurgy/rapid alloy screening
Alloy development cycle

4. **"Green" (sustainable) metallurgy and metals recycling**

Keywords

Learning Prerequisites

Required courses

Metals and Alloys, Thermodynamics for Materials Science; Phase Transformations; Deformation of

Materials; fundamental courses in physics

Recommended courses

Fracture of materials; Corrosion and protection of metals

Important concepts to start the course

Understanding phase diagrams and phase transformations; deformation of metals and strengthening mechanisms

Learning Outcomes

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

- Sketch the general physical and mechanical properties of the most relevant metals and alloys
- Sketch the correlation between composition, microstructure and properties for the main alloy classes
- Propose adequate metals and alloys for a given set of requirements and applications
- Judge the veracity of tabulated values in Handbooks

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Demonstrate the capacity for critical thinking
- Access and evaluate appropriate sources of information.
- Write a scientific or technical report.
- Summarize an article or a technical report.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.

Teaching methods

Ex-Cathedra, exercises, case studies

Expected student activities

- Attendance at lectures
- Completion of exercices
- Completion of two smaller case studies in groups of 3-4 students; this includes a short written report for each case study

Assessment methods

Two student case studies during the semester (25% each), one oral exam (50%)

Supervision

Office hours	Yes
Assistants	Yes

Prerequisite for

Master's Project; life in industry.