MSE-422

Advanced metallurgy

Weber Ludger

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

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

Summary

This course covers advanced metals and alloys both in terms of specific alloy classes (e.g. Ni-base, Ti-base, Mg-base, precious metals, High Entropy alloys, Metallic glasses) as well as general concepts (e.g. electrical and thermal properties, general characteristics of metallic melts and solids).

Content

The course's goal is to enlarge the field of knowledge of students beyond the classical three metals and alloy classes (i.e. iron and steel, aluminium, copper and their alloys) and to deepen the understanding of general characteristics of metals and alloys both in the liquid and in the solid state. In particular the technological important classes of Ni-base, Ti-base, and Mg-base alloys will be discussed allong with precious metal metallurgy and intermetallics and also touching on some of the more modern developments e.g. metallic glasses and high entropy alloys. Special purpose metallic materials will be treated as well. The students will be introduced to hands-on thermodynamical stability calculations involving (solid) solutions, including potential reactions with crucible material. Another purpose is install the capacity to estimate certain properties based on a set of rules of thumb and knowledge of the phase diagram of the system at hand. Some quantitative models based on electronic theory (e.g. phase stability, heat of mixing) will be discussed as well.

Keywords

- Thermophysical characteristics of liquid metals
- Interactions between liquid metals and the environment
- Thermodynamic descriptions of the liquid metal phase
- Frozen-in liquid metals—metallic glasses
- Thermodynamics of multicomponent systems
- Ni-base alloys
- Ti-base alloys
- Precious metals
- Mg-base alloys
- Intermetallics
- Special purpose metals and alloys
- High entropy alloys
- Electronic properties of metals

Learning Prerequisites

Required courses

Physics I-IV, Metals and Alloys, Phase transformation, Thermodynamics of mixtures,

Recommended courses

Solid state physics

Important concepts to start the course

Understanding phase diagrams
Quantum mechanics
"Free" electrons in a metal
Phase transformations

Learning Outcomes

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

- Assess / Evaluate the stability of various phases against a metallic melt
- Estimate the evolution of the electrical and thermal conductivity of an alloy with temperature
- Sketch the general physical and mechanical properties of the dominant metals and alloys
- Propose adequate metals and alloys for a given set of requirements
- Judge the veracity of tabulated values in Handbooks

Transversal skills

- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Demonstrate the capacity for critical thinking

Teaching methods

Ex-Cathedra, exercises

Expected student activities

Pondering problems to find what they need to know next and what they do not know yet (learning by doing).

Assessment methods

exam

Prerequisite for

Master's Project; life in industry.