

MSE 422-Advanced Metallurgy – Course Information

General remark

As the name “Advanced Metallurgy” implies, the students are expected to have some basic background in metallurgy. What is considered as already achieved is based on the syllabus of what B.S. students in Materials Science at EPFL have seen in their courses. For those coming from other universities or those having a B.S. in another subject, either from EPFL or another university, some additional work in personal reading might be necessary.

Date and time of lectures

- The course will take place on Wednesdays, 11:15-13:00 and 14:15-16:00 in INM10 – start 11/09/2024.
- The course consists of 3h of lectures plus 1h of exercises per week (4 credit points). However, the exercises will take place every second week 14:15-16:00 (2h) for organizational reasons – start 18/09/2024.
- The exercises are complementary to the lectures. They are meant as a reminder for certain topics from previous courses or to deepen the knowledge of the most important parts of the lectures through calculation exercises, case studies or software demonstrations.

Course outline

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.

1. Reminder

Thermodynamics of alloys and phase diagrams
Solid and liquid state phase transformations; diffusion; nucleation and growth
Mechanical behavior at low/high T; 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
Ti alloys
Al and Mg alloys
Structural intermetallics (e.g. TiAl, FeAl)
High entropy alloys and bulk metallic glasses
Precious metals (Au, Pt alloys)

3. Introduction into alloy design

Thermodynamic/kinetic modeling using Thermo-Calc; integrated computational materials engineering

Combinatorial metallurgy/rapid alloy screening

4. Metals processing; "green" (sustainable) metallurgy; metals recycling

Primary and secondary steel metallurgy

Current approaches to sustainable steel metallurgy

Primary and secondary Al metallurgy; Recycling

Metals manufacturing

Course notes and exercises

- The lecture slides will be uploaded on Moodle latest ~1 day before the lecture. However, I might make some last-minute changes.
- The exercise sheets with problems/questions will be uploaded latest 1 week before the exercise will take place.
- The TAs will support you with solving the problems during the exercise sessions. While solving the exercises is not mandatory, it is highly recommended that the students try to find their own solutions. Some questions cannot be answered with the course notes only and finding/reading additional literature might be required.

Teacher

- MER Dr. Christian Leinenbach (christian.leinenbach@epfl.ch)
- On EPFL campus: every Wednesday during the semester
- If you are interested in Semester Projects or PDM on advanced metallurgy and metals processing, come and see me

Teaching assistants

- Jian Yang (jian.yang@epfl.ch)
- Seyyed Ezzatollah Moosavi (ezzatollah.moosavi@epfl.ch)
- The teaching assistants will provide support regarding the organization of the course, questions concerning the exercises and the case study

Assessment

- One group homework for teams of 3-4 students during the semester (50%). More information will be provided during the first lecture and on Moodle
- A written exam at the end of the semester (90 mins, 50%); the students are allowed to prepare two hand-written sheets of A4 paper with information they think is useful for the exam.