Statistical Mechanics and Fundamental Materials Physics (iMOS)

Module	**Credits**	**Workload**	**Term**	**Frequency**	**Duration**
2 EC	5 CP	150 h	1. Sem.	Each WiS	1 Semester
Courses a) Lectures b) Exercises			**Contact hours** a) 3 SWS b) 1 SWS	**Self-Study** 90 h	**Group size** 20 Students

Prerequisites

Admission to M.Sc. iMOS

Learning outcomes

Students are able to describe the basic concepts of mechanical behaviour of materials. They gain an overview on the different mechanical properties and their assessment methods, including the microstructural strengthening mechanisms of materials. They understand the definition of mechanical equilibrium and are able to apply it to solve simple problems. They also memorize basic thermodynamic concepts for phase stability and liquid-solid or solid-solid phase transformations, as Maxwell relations and phase diagrams.

The students can apply statistical methods to connect physical quantities such as temperature, hydrostatic pressure and stress tensor to atomic and molecular features. They memorize approximate microscopic models and can apply them to describe heat capacity, electric conductivity, mechanical properties and magnetism. On the mesoscopic side, they can employ variational approaches to examine phase separation and domain growth.

Content

- Introduction to mechanical properties of materials and their assessment methods
- Microscopic origin of plastic deformation and fracture
- Thermodynamical concepts to describe phase equilibria and phase transformations in
- liquid and solid states
- Introduction to functional (electrical, magnetic, optical) properties of materials
- Introduction to probability theory and statistical ensembles
- Classical and quantum statistics (Boltzmann, Fermi and Bose-Einstein)
- Heat capacity of crystalline solids (Debye theory)
- Magnetism (para-magnetism and mean field theory of ferro-magnetism)

Teaching methods

Lecture and group work in exercises.

Mode of assessment

Written examination (2 hours), bonus points can be gained by providing solutions to the problem sheet in class.

Requirement for the award of credit points

Passing the examination

Module applicability

M.Sc. iMOS

Weight of the mark for the final score

According to CP

Module coordinator and lecturer(s)

Prof. Dr. Alexander Hartmaier, Prof. Dr. Fathollah Varnik
lecturers from the *Interdisciplinary Centre for Advanced Materials Simulation (ICAMS)*

Further information

These course components are also in the RUB M.Sc. Module Handbook Material Science and Simulation as Required Course Module 2c.

Literature: McQuarrie: Statistical Mechanics, C. Garrod: Statistical mechanics and thermodynamics, D.R. Gaskell; Introduction to the thermodynamics of materials, D.A. Porter & K.E. Easterling; Phase transformation in metals and alloys.