TECHNISCHE HOCHSCHULE LÜBECK

Module: Polymer Science

Level	Master	**Short Name**	PSci
Responsible Lecturers	Prof. Dr.-Ing. Olaf Jacobs		
Department, Facility	Mechanical Engineering and Business Administration		
Course of Studies	Mechanical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	5
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	150
Frequency	WiSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	120	**Exam Grading System**	One-third Grades

Learning Outcomes

The students will be able to

- describe the different types of polymerisation reactions and to assign typical plastics to the according polymerisation types,
- distinguish thermoplastics, thermosets, elastomers, and TPEs with respect of structure, processing and usage properties and to select among these material families for practical applications,
- describe the most common representatives of the aforementioned polymer families with respect to structure, processing and usage properties and to specify typical advantages and shortcomings,
- name typical additives for polymers, explain their effect on the material properties, and describe the most common compounding methods,
- describe qualitatively and mathematically the mechanical (non-linear elasticity, creep, visco-elasticity), physical (dielectricity, interaction with radiation), thermal (transitions, solidification and melting), thermo-mechanical (DMTA, residual stresses from processing), and chemical (oxidation, soaking) peculiarities of polymeric materials,
- describe and explain typical testing and analysis procedures for polymers,
- describe and explain processing effects on the performance of polymers and plastic products,
- describe the most common processing methods (injection moulding, extrusion, thermoforming) and common derivatives of them.

Participation Prerequisites

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✔ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Composite Materials MSc thesis
Remarks	

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Polymer Science (Lecture)

(of Module: Polymer Science)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	5
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	150
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	90
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents

Polymerisation

- carbon atom and its bonds (single, double, triple, steric structure)
- radical chain polymeriosation, ionic chain polymeriosation, step reaction, polycondensation, ring opening polymerisation
- catalysts and their effect on the chain structure (Zigler-Natta, metallocene)
- degree of polymerisation, molar mass and their measurement
- branching ratio

Structure property relationship

- constitution (dipoles, voluminous side groups, rigid back bone segments)
- configuration (tacticity)
- crystallisation and crystallinity (effect of molecular structure), structural anisotropy and anisotropic properties
- copolymers (block, random, grafting)

Compounding

- Additives and their effect (fillers, reinforcements, plasifiers, lubricants, release agents, stabelisers etc.)
- dispersion and homogenisation

Rheology of polymers

- Newtoneon and non-Newtoneon fluids, power law, shear thinning, Carreau equation
- flow induced anisotropy

	• measurement methods: viscosimeters, MVR/MFR, high pressure capillary rheometer **Thermal properties of polymers** • phase transitions: molecular processes, mathematical models • solidification of melts, shrinkage, skin-core morphology in injection moulded parts **Mechanicel properties of polymers** • viscoelasticity: energy elasticity, entropy elasticity, creep/ relaxation; molecular processes, mathematical models, relaxation time • cyclic loading: DMA, effect of temperature and frequency, time/ temperature transformations, master curves, Arrhenius and WLF transformation • stress-strain behaviour, creep curves and creep modulous **Electrical properties of polymers** • Condution mechanisms in polymer compounds, percolation, anti-static compounds • Dielectric constant, polarisation mechanisms, frequency effect, practical relevance (capacitors, HF welding, absorption of electromagnetic waves) **Environmental effects** • Diffusion processes in polymers, barrier properties, • Chemical interaction with media, oxidation, surface activation • Physikal interaction, soaking, softening and internal stresses • Radiation and thermal effects: radiation induced processes, aging, radiation curing/crosslinking, stabelisers and activators • Accelerated aging, testing methods and correlation with reality. Arrhenius relation **Polymer Processing and Recycling** • Injection Moulding and derivates, extrusion and derivates, thermoforming and derivates, • Differences between thermoplastics, thermostets, and elastomers, • Material recycling, recycling to resources, thermal recycling: Practical examples, state of the art and trends.
Literature	• Jacobs, O. : Polymer Science, lecture notes, FH Lübeck • updated textbook list will be supplied at the beginning of the semester
Remarks	