Polymer Materials Processing – 2026 (7.5 hp)

KF2505

Overview:

This course provides a comprehensive understanding of polymer processing, focusing on thermoplastics, thermosets, and rubbers, and their transformation into final products.

It covers the relationship between polymer macromolecular structures and processing behaviors, emphasizing melt processing of thermoplastics and key factors such as melting, rheology, viscosity, molecular orientation, and crystallization. Industrial techniques such as extrusion, injection molding, hot forming, film blowing, calendaring, and 3D-printing are thoroughly discussed alongside the mechanical properties of processed materials, accounting for viscoelasticity, plasticity, deformation rates, and temperature effects.

The course also explores thermosetting polymers, particularly their role in fiber-reinforced composites, detailing laminate formation, impregnation techniques, and curing processes.

Additionally, cross-linked elastomers are examined, and practical exercises like natural rubber vulcanization are included. Students engage in projects analyzing polymer material selection for specific products, considering processing environments, material demands, production costs, and potential improvements.

By the end of the course, students will have acquired a solid understanding of thermoplastics, thermosets, and rubbers, equipping them to optimize polymer processing methods in industrial applications.

Learning goals:

After completing the course, the student shall be able to:

- Describe the differences in processing strategies of different polymers as related to their ability to carry out continuous or intermittent polymer processing.
- Carry out the basics in processing thermosets, thermoplastics, and elastomeric materials in a processing laboratory.
- Relate processing conditions to specific processing equipment, considering the rheological flow behavior of polymers in injection molding, extruders (with film-blowing systems), calendaring equipment, hot molding, vacuum forming, rotational molding, etc., as well as vacuum-bagging techniques for fiber laminate preparation.
- Describe the relevance of crystals and to what extent crystallization and post-processing actions can be used to improve the performance of the polymer products.
- Describe the internal components, functions, and relevance of the most common polymer processing machinery used in the industry.
- Describe how fiber laminates, sewage pipes, vinyl floors, fiber-reinforced inflatable boats, plastic bags, PET bottles, car tires, and the most frequently encountered large-scale-produced polymer products are made in the industry.

More specific learning goals are handed out at the start of each lecture. 8-12 learning goals accompany each lecture to facilitate studying and repetition of the lecture content.

Course literature

1. Handouts and lecture notes.

2. D. H. Morton – Jones: Polymer Processing; Chapman and Hall, 1989: ISBN: 0 412 26 690/700 is available in the Kårbokhandel or Amazon.com

Reading instructions (D. H. Morton)

A concise guide to the most important sections to study in the presented material is handed out after each lecture. Learning goals are presented at the start of each lecture session. The students are

encouraged to complement all learning goals on their own by additional reading in Morton et al. or equivalent literature.

Project

The final version of the student project report should be emailed to the course responsible before the course-ending seminar or handed in directly to the course responsible.

Examination

The course is divided into three sections that are examined separately.

1) The lectures are assessed in a written examination graded from A to F, with E as the minimum passing grade. 10 questions are given (total 100 points, where 50 points are equivalent to passing and the mark E). In rare cases, the grade F_x is given, meaning the student can ask for an assignment to reach the grade E. *This section of the course is equivalent to 4.5 hp.*
2) The material selection projects are graded as P or F (pass or fail) and will be based on the student's ability to review the use and material choices in a selected product and to provide constructive criticism on one of their peers' reports. *This section of the course is **compulsory** and equivalent to 1.5 hp.*
3) Laboratory exercises (three labs: extrusion, injection, and rubber) are compulsory and will be graded as P or F. *This section of the course is **mandatory** and equivalent to 1.5 hp.*

The final grade will be reported when all the sections have been completed, based on the grade obtained on the written exam.

Course Responsible: Antonio Capezza (AC) ajcv@kth.se / Richard Olsson (RO) rols@kth.se

Examiner: Richard Olsson (RO), Fiber and Polymer Technology, Teknikringen 56, ph. 073-2701868

If you have questions, please get in touch with the Course Responsible or Examiner.

Welcome to the course!

SCHEDULE:

Lecture	Date	Time	Place	Content
INFO	Tue 25/8	13-15	Rånby	Introduction and organization of the course + Project information (AC/RO)
F1	Wed 26/8	13-15	Rånby	Background to the use of polymers in industry + Material selection methods and product to the market (RO)
F2	Thu 27/8	13-15	Rånby	Polymer material categories, relation between structure and properties and conditions for processing (RO)
F3	Fri 28/8	08-10	Rånby	Extrusion to product (PP)
F4	Mon 31/8	08-10	Rånby	Biopolymers + Sustainable production (AC)
F5	Tue 1/9	13-15	TreeSearch _Stora	Film blowing, calendaring and hot forming (RO)
F6	Wed 2/9	10-12	Rånby	Injection molding to product (XF)
F7	Thu 3/9	10-12	TreeSearch Stora	Materials simulation and data interpretation via computers (FN)

F8	Tue 8/9	08-10	Rånby	Rheology of polymer melts with related parameters and viscoelastic models for describing materials behaviors' (MH)
F9	Wed 9/9	13-15	Rånby	Foam materials (HL)
F10	Thu 10/9	10-12	Rånby	Thermosets and fiber composites + Natural and synthetic elastomers (RO)

F11	Fri 11/9	08-10	Rånby	Functional plastic additives and their impact on polymer processing (MH)
F12	Mon 14/9	17-19	Rånby	3D-Printing polymer materials (AM) + Microplastics degradation (XF)
VISIT SWIC	Tue 15/9	13-15 (lunch 12)	Rånby	Challenges w plastics in advanced water treatment facilities (lunch and study vist at IVL –SWIC)
F13	Wed 16/9	10-12	TreeSearch _Stora	Long-term performance of polymeric materials (PP)
LAB	Tue 22/9	08-13	PRO	EX, IM, RP – Gr 1
LAB	Wed 23/9	13-18	PRO	EX, IM, RP – Gr 2
LAB	Thu 24/9	08-13	PRO	EX, IM, RP – Gr 3
LAB	Mon 28/9	13-18	PRO	EX, IM, RP – Gr 1
LAB	Tue 29/9	08-13	PRO	EX, IM, RP – Gr 2
LAB	Wed 30/9	13-18	PRO	EX, IM, RP – Gr 3
LAB	Thu 1/10	08-13	PRO	EX, IM, RP – Gr 1
LAB	Thu 1/10	13-18	PRO	EX, IM, RP – Gr 2
LAB	Fri 2/10	08-13	PRO	EX, IM, RP – Gr 3
SEMINAR	Fri 2/10	13-18	Rånby	Presentation of projects compulsory presence. (AC/RO)
Exam	Thu 21/10	08-13	D41	Final examination

Marked areas are to be determined at the start of the course.

Rånby room = Teknikringen 56 (2nd floor).
TreeSearch Stora = Teknikringen 38a (2nd floor).

Teachers and teacher assistants:

RO = Richard Olsson (rols@kth.se)
AC = Antonio Capezza (ajcv@kth.se)
MH = Mikael Hedenqvist (mikaelhe@kth.se)
PP = Payam Pourmand (pourmand@kth.se)
FN = Fritjof Nilsson (fritjofn@kth.se)
XF = Xinfeng Wei (xinfengw@kth.se)
HL = Huisi Li (huisi@kth.se)
AM = Anran Mao (anranmao@kth.se)