

## Pflichtmodule

### INW.05559.04 - Polymer Engineering

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INW.05559.04                                  | 10 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Modulbezeichnung</b>                       | Polymer Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Modulcode</b>                              | INW.05559.04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Beate Langer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>The students acquire perspectives for the work as a polymer scientist or polymer engineer.</li> <li>They receive the basic knowledge on processing of polymer materials and polymer testing.</li> <li>They will be enabled in practical skills of processing of polymer materials.</li> <li>They also learn about practical skills in mechanical and physical testing of polymer materials.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulinhalte</b>                           | <p>This module covers basic topics of polymer engineering. The lecture Polymer Processing gives an overview on the general aspects of polymer processing, i.e. handling of polymers from engineering point of view, the lecture Polymer Testing deepens the view on the characterization methods on macroscopic level. The lab courses Polymer processing and testing accompany the lectures and show the details of performing such experiments.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>Lecture Polymer Processing<br/>Basics of melt flow, extrusion, injection molding, spinning, foaming, elastomer processing, processing tires, blown film extrusion, recycling of polymer materials</li> <li>Lecture Polymer Testing<br/>Elastic, visco-elastic and plastic deformation behavior of polymer materials and phenomenological models, quasi-static test methods of polymer materials (tensile, compression, bending), hardness measurement and test methods, charpy impact test, instrumented impact tests as methods for toughness characterizations of polymer materials, fracture mechanics concepts for polymer materials</li> </ol> <p>Lab Courses:</p> <ol style="list-style-type: none"> <li>Polymer Processing Lab<br/>Extrusion, injection molding, elastomer processing, blown film extrusion</li> <li>Polymer Testing Lab<br/>Characterization of elastic properties, tensile test, dynamic-mechanical analysis, bend test, ball indentation test, Charpy impact test, drop weight test, tensile impact test</li> </ol> |
| <b>Lehrveranstaltungsformen</b>               | Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Praktikum (1 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (2 SWS)<br>Kursus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Unterrichtsprachen</b>                     | Deutsch, Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Dauer in Semestern</b>                     | 2 Semester Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Angebotsrhythmus Modul</b>                 | jedes Wintersemester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Aufnahmekapazität Modul</b>                | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Prüfungsebene</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Credit-Points</b>                          | 10 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

INW.05559.04

10 CP

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|-------------------------------------------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Modulabschlussnote                                    |                            |                                                                                                                                                                                                                  | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %. |                     |                                  |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                                                                  |                                                       | 1                   |                                  |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                                                                              |                                                       |                     | Prüfungsform                     |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| Gesamtmodul                                           |                            | written examination and seminar problem set solutions Polymer Processing, written examination Polymer Testing, completed lab course protocols Polymer Processing, completed lab course protocols Polymer Testing |                                                       |                     | oral or written examination      |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                                                                          | SWS                                                   | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Polymer<br>Processing                                                                                                                                                                                 |                                                       | 2                   |                                  |                                        |                                           | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Polymer<br>Processing                                                                                                                                                                                 |                                                       | 1                   |                                  |                                        |                                           | 0                 |
| LV 3                                                  | Praktikum                  | Lab Course<br>Polymer<br>Processing                                                                                                                                                                              |                                                       | 1                   |                                  |                                        |                                           | 0                 |
| LV 4                                                  | Vorlesung                  | Lecture<br>Polymer Testing                                                                                                                                                                                       |                                                       | 2                   |                                  |                                        |                                           | 0                 |
| LV 5                                                  | Praktikum                  | Lab Course<br>Polymer Testing                                                                                                                                                                                    |                                                       | 2                   |                                  |                                        |                                           | 0                 |
| LV 6                                                  | Kursus                     | Private study                                                                                                                                                                                                    |                                                       |                     |                                  |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  | 300                                    |                                           | 300               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                                                                                  |                                                       |                     |                                  |                                        |                                           | 300               |

## PHY.05548.04 - Basics of Materials and Polymer Physics

PHY.05548.04

10 CP

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|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Basics of Materials and Polymer Physics                                                                                                                                                                            |
| <b>Modulcode</b>                              | PHY.05548.04                                                                                                                                                                                                       |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                    |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                    |
| <b>Weitere verantwortliche Personen</b>       | Dr. Karsten Busse                                                                                                                                                                                                  |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                    |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                    |

- The students learn about the central physical concepts in materials science.
- The students learn and train the necessary mathematical skills.
- They will be enabled in planning, performing and evaluating scientific experiments using modern instrumentation. This includes error estimation and analysis, recording, evaluating and presenting measurement data and writing a report.

### Modulinhalte

This module covers basic theoretical details of polymer physics and physical chemistry. The lectures Introduction to Materials Physics (1) and Mathematical and Theoretical Concepts for Polymer Science (2) act as refresher or introductory courses for the main mathematical tools and solid state properties. The Lab course Basic Physics and Physical Chemistry Lab give the students the opportunity to get an idea for the handling of characterization experiments.

Lectures:

#### 1. Introduction to Materials Physics

- Atoms and bonds, crystal structures
- Structure analysis: microscopy techniques
- Basics of scattering (Bragg and crystal structures, wave equation, interference, structure factor)
- Phase transitions and phase diagrams
- Mechanical properties of solids
- Thermal, optical, magnetic, electric and dielectric properties

#### 2. Mathematical and Theoretical Concepts for Polymer Science

- Mathematical tools (linear algebra, trigonometry, complex numbers, Fourier transformation, delta function)
- Calculus: integration, differentiation, solving differential simple equations, applications to reaction kinetics and simple mechanical polymer models
- Statistics: distribution functions (mol. weight distributions, averages and moments), data treatment, error handling, linear regression
- Diffusion, Brownian motion and random walks; single-chain structure (Gaussian coil, radius of gyration)
- Basics of computer simulation techniques (interaction potentials, MD vs. MC)
- Introduction to quantum mechanics: Schrodinger equation, wave functions, particle in a box, harmonic oscillator, hydrogen atom, bonding

Lab course - Basic Physics and Physical Chemistry Lab:

9 experiments are performed. Each experiment consists of 4 hours lab time and private study of basics, writing the protocol and evaluating the experiment. The lab includes a tutorial experiment (radioactivity) that includes an introduction into the Origin software. The list of experiments is subject to changes. Current experiments are:

- Viscosity (falling ball viscometer)
- Humidity (dew point hygrometer)
- RLC oscillator (oscilloscope handling)

- Diffraction spectrometer (optical spectroscopy)
- Polarimeter and refractometer
- X-ray methods (spectrum of Mo tube, dosimetry)
- Vapor pressure and heat of vaporization (Clausius-Clapeyron)
- Freezing point depression
- Surface tension of liquids
- Solubility diagram of liquids (miscibility gap)

|                                                       |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
|-------------------------------------------------------|----------------------------|----------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------|----------------------------------------------------------------------------------------|-------------------|---|
| Lehrveranstaltungsformen                              |                            |                                                                                  |     | Vorlesung (1 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (3 SWS)<br>Seminar (1 SWS)<br>Seminar (2 SWS)<br>Kursus |                                  |                                        |                                                                                        |                   |   |
| Unterrichtssprachen                                   |                            |                                                                                  |     | Deutsch, Englisch                                                                                           |                                  |                                        |                                                                                        |                   |   |
| Dauer in Semestern                                    |                            |                                                                                  |     | 1 Semester Semester                                                                                         |                                  |                                        |                                                                                        |                   |   |
| Angebotsrhythmus Modul                                |                            |                                                                                  |     | jedes Wintersemester                                                                                        |                                  |                                        |                                                                                        |                   |   |
| Aufnahmekapazität Modul                               |                            |                                                                                  |     | unbegrenzt                                                                                                  |                                  |                                        |                                                                                        |                   |   |
| Prüfungsebene                                         |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| Credit-Points                                         |                            |                                                                                  |     | 10 CP                                                                                                       |                                  |                                        |                                                                                        |                   |   |
| Modulabschlussnote                                    |                            |                                                                                  |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %.                                                       |                                  |                                        |                                                                                        |                   |   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                  |     | 1                                                                                                           |                                  |                                        |                                                                                        |                   |   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                              |     |                                                                                                             | Prüfungsform                     |                                        |                                                                                        |                   |   |
| LV 1                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| LV 2                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| LV 3                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| LV 4                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| LV 5                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| LV 6                                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| Gesamtmodul                                           |                            |                                                                                  |     | completed lab course protocols, Seminar problem set solutions                                               |                                  |                                        | oral or written examination (Materials Physics, mathematical and theoretical concepts) |                   |   |
| Wiederholungsprüfung                                  |                            |                                                                                  |     |                                                                                                             |                                  |                                        |                                                                                        |                   |   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                          | SWS | Workload<br>Präsenz                                                                                         | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung                                              | Workload<br>Summe |   |
| LV 1                                                  | Vorlesung                  | Lecture<br>Introduction to<br>Materials<br>Physics                               |     | 1                                                                                                           |                                  |                                        |                                                                                        |                   | 0 |
| LV 2                                                  | Vorlesung                  | Lecture<br>Mathematical<br>and Theoretical<br>Concepts for<br>Polymer<br>Science |     | 2                                                                                                           |                                  |                                        |                                                                                        |                   | 0 |
| LV 3                                                  | Praktikum                  | Lab course<br>Basic Physics<br>and Physical<br>Chemistry Lab                     |     | 3                                                                                                           |                                  |                                        |                                                                                        |                   | 0 |
| LV 4                                                  | Seminar                    | Seminar<br>Introduction to<br>Materials<br>Physics                               |     | 1                                                                                                           |                                  |                                        |                                                                                        |                   | 0 |
| LV 5                                                  | Seminar                    | Seminar<br>Mathematical<br>and Theoretical<br>Concepts for<br>Polymer<br>Science |     | 2                                                                                                           |                                  |                                        |                                                                                        |                   | 0 |
| LV 6                                                  | Kursus                     | Private Study                                                                    |     |                                                                                                             |                                  |                                        |                                                                                        |                   | 0 |

| Modulveranstalt<br>ung          | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel | SWS | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
|---------------------------------|----------------------------|-------------------------|-----|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| <b>Workload modulbezogen</b>    |                            |                         |     |                     |                                  | 300                                    |                                           | 300               |
| <b>Workload Modul insgesamt</b> |                            |                         |     |                     |                                  |                                        |                                           | 300               |

## CHE.05560.04 - Polymer Engineering Science

CHE.05560.04

8 CP

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|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Polymer Engineering Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Modulcode</b>                              | CHE.05560.04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Michael Bartke                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>• The students acquire perspectives for the work as a polymer engineer.</li> <li>• They study basics of technical/industrial polymerization processes and instrumentation</li> <li>• They receive the theoretical background on basic knowledge of polymerization kinetics, kinetic modeling approaches, design of polymerization reactors and industrial polymerization processes.</li> <li>• They acquire a basic knowledge about physical properties of polymeric materials, including composites.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Modulinhalte</b>                           | <p>This module covers advanced topics of polymer engineering. The lectures Polymer Reaction Engineering and Polymeric Materials combine the experience from lab scale to the requirements of industrial application.</p> <p>Lectures:</p> <p>1. Polymer Reaction Engineering</p> <ul style="list-style-type: none"> <li>• Classification of polyreactions and polymerization processes</li> <li>• Kinetics and kinetic modeling of polymerizations and molecular weight distributions (free-radical, emulsion, coordinative polymerization)</li> <li>• Rheological properties of reaction mixtures</li> <li>• Design and dimensioning of polymerization reactors, heat removal, mixing, non-idealities</li> <li>• Industrial polymerization processes</li> <li>• Seminar topics (Material balances of ideal chemical reactors; Calculation of polymerization kinetics on selected examples; Calculation of molecular weight distributions; Application examples on dimensioning of polymerization reactor; Heat removal calculations for polymerization reactors; examples on non-ideal reactors and selectivity effects)</li> </ul> <p>2. Polymeric Materials</p> <ul style="list-style-type: none"> <li>• Chemical and physical structure, Liquid/melt - solid transition: crystallization / glass transition</li> <li>• Mechanical behaviour: elastic deformation / rubbery-elasticity / visco-elastic behavior of polymeric solids / plastic deformation, Basics of melt flow</li> <li>• Thermal, optical, electrical, acoustic properties of polymers</li> <li>• Polymeric materials: structure, properties, applications:</li> </ul> <p>a) Thermoplastics (commodity polymers, polyesters/-amides, high-performance polymers)</p> <p>b) Elastomers</p> <p>c) Thermosets</p> <p>d) Blends and composites</p> <ul style="list-style-type: none"> <li>• Material balances of ideal chemical reactors</li> <li>• Calculation of polymerization kinetics on selected examples</li> <li>• Calculation of molecular weight distributions</li> </ul> <p>Examples on non-ideal reactors and selectivity effects</p> <p>Polymer Computer Modelling</p> |

CHE.05560.04

8 CP

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|-------------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------------|-------------------------------|----------------------------------|-------------------------------------|----------------|
| Lehrveranstaltungsformen                              |                        |                                                                                                                   |     | Vorlesung (2 SWS)<br>Seminar (2 SWS)<br>Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Kursus |                               |                                  |                                     |                |
| Unterrichtsprachen                                    |                        |                                                                                                                   |     | Deutsch, Englisch                                                                      |                               |                                  |                                     |                |
| Dauer in Semestern                                    |                        |                                                                                                                   |     | 1 Semester Semester                                                                    |                               |                                  |                                     |                |
| Angebotsrhythmus Modul                                |                        |                                                                                                                   |     | jedes Wintersemester                                                                   |                               |                                  |                                     |                |
| Aufnahmekapazität Modul                               |                        |                                                                                                                   |     | unbegrenzt                                                                             |                               |                                  |                                     |                |
| Prüfungsebene                                         |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| Credit-Points                                         |                        |                                                                                                                   |     | 8 CP                                                                                   |                               |                                  |                                     |                |
| Modulabschlussnote                                    |                        |                                                                                                                   |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %.                                           |                               |                                  |                                     |                |
| Faktor der Modulnote für die Endnote des Studiengangs |                        |                                                                                                                   |     | 1                                                                                      |                               |                                  |                                     |                |
| Prüfung                                               |                        | Prüfungsvorleistung                                                                                               |     |                                                                                        | Prüfungsform                  |                                  |                                     |                |
| LV 1                                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| LV 2                                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| LV 3                                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| LV 4                                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| LV 5                                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| Gesamtmodul                                           |                        | seminar (Polymer Reaction Engineering) problem set solutions, seminar (Polymeric Materials) problem set solutions |     |                                                                                        | oral or written examination   |                                  |                                     |                |
| Wiederholungsprüfung                                  |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     |                |
| Modulveranstaltung                                    | Lehrveranstaltungsform | Veranstaltungstitel                                                                                               | SWS | Workload Präsenz                                                                       | Workload Vor- / Nachbereitung | Workload selbstgestaltete Arbeit | Workload Prüfung incl. Vorbereitung | Workload Summe |
| LV 1                                                  | Vorlesung              | Lecture Polymer Reaction Engineering                                                                              |     | 2                                                                                      |                               |                                  |                                     | 0              |
| LV 2                                                  | Seminar                | Seminar Polymer Reaction Engineering                                                                              |     | 2                                                                                      |                               |                                  |                                     | 0              |
| LV 3                                                  | Vorlesung              | Lecture Polymeric Materials                                                                                       |     | 2                                                                                      |                               |                                  |                                     | 0              |
| LV 4                                                  | Seminar                | Seminar Polymeric Materials                                                                                       |     | 1                                                                                      |                               |                                  |                                     | 0              |
| LV 5                                                  | Kursus                 | Private study                                                                                                     |     |                                                                                        |                               |                                  |                                     | 0              |
| Workload modulbezogen                                 |                        |                                                                                                                   |     |                                                                                        |                               | 240                              |                                     | 240            |
| Workload Modul insgesamt                              |                        |                                                                                                                   |     |                                                                                        |                               |                                  |                                     | 240            |

## CHE.05562.06 - Polymer Chemistry

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CHE.05562.06                                  | 10 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Modulbezeichnung</b>                       | Polymer Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Modulcode</b>                              | CHE.05562.06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Wolfgang Binder                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>• The students can apply their knowledge of basic concepts of polymer synthesis, terminology, synthesis, and characterization of composition and molar mass and distributions.</li> <li>• They deepen their knowledge of basic concepts of organic chemistry and polymer synthesis.</li> <li>• They understand and can qualify the role of synthetic polymers, including the necessities and their recycling strategies in view of modern societal needs and demands.</li> <li>• They learn to handle chemicals safely, basics of organic/polymer synthesis, preparation and purification techniques.</li> <li>• They can apply analytical methods for structural and materials applications.</li> <li>• They learn about writing of scientific reports.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Modulinhalte</b>                           | <p>This module covers basic topics of polymer chemistry. The lecture Introduction to Macromolecules gives an overview on the general aspects of polymers and the lecture Organic Chemistry and Polymer Synthesis deepens the view on the basic synthesis and characterization methods. The lab course Basic Chemistry and Polymerization Lab allows the student to perform their first polymerization including all preparative steps like distillation of educts up to precipitation of products.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>1. Introduction to Macromolecules           <ul style="list-style-type: none"> <li>• General introduction and history of polymer science</li> <li>• General principles of polymer synthesis (step growth, chain growth, thermodynamics, kinetics, copolymerization, technical polymerizations, living polymerization)</li> <li>• Reactions with polymers: isomerization, grafting, crosslinking</li> <li>• Basics of polymer characterization: end-group titration/NMR, osmometry, viscosity, chromatography, mass spectrometry, Flory-Huggins theory, polymer additives</li> <li>• Microphase-separated polymers: block copolymers, thin films, amphiphilic polymers in solvents, micelles, polymer crystallization, amorphous state</li> <li>• Polymer materials and their bioprofiles (recycling, degradation, biological assessments)</li> <li>• Applications of polymers in medicine, microelectronics, in society.</li> </ul> </li> <li>2. Organic Chemistry and Polymer Synthesis           <ul style="list-style-type: none"> <li>• Basic principles of organic chemistry</li> <li>• Reaction mechanisms in organic chemistry</li> <li>• Principles of homogeneous and heterogeneous catalysis</li> <li>• Basics of solution-state NMR</li> <li>• Free-radical and controlled free-radical polymerizations</li> <li>• Living polymerizations, block copolymer synthesis</li> <li>• Catalytic polymerizations (Ziegler/Natta, metallocene, ROMP)</li> <li>• Polycondensation</li> <li>• Network synthesis/thermosets</li> </ul> </li> </ol> <p>Lab course:</p> <ol style="list-style-type: none"> <li>1. Basic Chemistry and Polymerization Lab</li> </ol> |

- Basic operations (distillation, recrystallization, precipitation)
- Esterification, amidation, Free-radical polymerization
- Suspension/emulsion polymerization, Resin preparation (amino-, epoxy-resins)

|                                                       |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Lehrveranstaltungsformen                              |                            |                                                                                                                                                                                                                           |     | Vorlesung (1 SWS)<br>Seminar (1 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (5 SWS)<br>Seminar (1 SWS)<br>Kursus |                                  |                                        |                                           |                   |
| Unterrichtsprachen                                    |                            |                                                                                                                                                                                                                           |     | Deutsch, Englisch                                                                                           |                                  |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                                                                                           |     | 1 Semester Semester                                                                                         |                                  |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                                                                                           |     | jedes Wintersemester                                                                                        |                                  |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                                                                                           |     | unbegrenzt                                                                                                  |                                  |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                                                                                           |     | 10 CP                                                                                                       |                                  |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                                                                                           |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %.                                                       |                                  |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                                                                           |     | 1                                                                                                           |                                  |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                                                                                       |     |                                                                                                             | Prüfungsform                     |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| Gesamtmodul                                           |                            | completed lab course protocols and lab-safety examinations, written examination Macromolecules, Organic Chemistry and Polymer Synthesis I, written examination Macromolecules, Organic Chemistry and Polymer Synthesis II |     |                                                                                                             | oral or written examination      |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                                                                                   | SWS | Workload<br>Präsenz                                                                                         | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Introduction to<br>Macromolecule<br>s                                                                                                                                                                          |     | 1                                                                                                           |                                  |                                        |                                           | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Introduction to<br>Macromolecule<br>s                                                                                                                                                                          |     | 1                                                                                                           |                                  |                                        |                                           | 0                 |
| LV 3                                                  | Vorlesung                  | Lecture Organic<br>Chemistry and<br>Polymer<br>Synthesis                                                                                                                                                                  |     | 2                                                                                                           |                                  |                                        |                                           | 0                 |
| LV 4                                                  | Praktikum                  | Lab course<br>Basic Chemistry<br>and<br>Polymerization<br>Lab                                                                                                                                                             |     | 5                                                                                                           |                                  |                                        |                                           | 0                 |
| LV 5                                                  | Seminar                    | Seminar<br>Organic<br>Chemistry and<br>Polymer<br>Synthesis                                                                                                                                                               |     | 1                                                                                                           |                                  |                                        |                                           | 0                 |
| LV 6                                                  | Kursus                     | Private study                                                                                                                                                                                                             |     |                                                                                                             |                                  |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  | 300                                    |                                           | 300               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                                                                                           |     |                                                                                                             |                                  |                                        |                                           | 300               |



## CHE.05565.02 - Master Thesis (M.Sc.)

|                                                              |                                                                                                                                                                                                                                                                                                                |              |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| CHE.05565.02                                                 | 30 CP                                                                                                                                                                                                                                                                                                          |              |
| <b>Modulbezeichnung</b>                                      | Master Thesis (M.Sc.)                                                                                                                                                                                                                                                                                          |              |
| <b>Modulcode</b>                                             | CHE.05565.02                                                                                                                                                                                                                                                                                                   |              |
| <b>Semester der erstmaligen Durchführung</b>                 |                                                                                                                                                                                                                                                                                                                |              |
| <b>Verwendet in Studiengängen / Semestern</b>                | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul>                                                                                             |              |
| <b>Modulverantwortliche/r</b>                                |                                                                                                                                                                                                                                                                                                                |              |
| <b>Weitere verantwortliche Personen</b>                      | Hochschullehrer der Institute Physik oder Chemie bzw. des Fachbereiches der Hochschule Merseburg                                                                                                                                                                                                               |              |
| <b>Teilnahmevoraussetzungen</b>                              | at least 75 Credit Points (75 LP)                                                                                                                                                                                                                                                                              |              |
| <b>Kompetenzziele</b>                                        | <ul style="list-style-type: none"> <li>The students will be enabled to carry out independent research.</li> <li>They will do literature studies and experimental work.</li> <li>Finally, the students write and defend their thesis.</li> </ul>                                                                |              |
| <b>Modulinhalte</b>                                          | This module covers the main part of the master course: The independent research work on a scientific or engineering based topic. The students must perform literature research, collect and evaluate experimental data, do their own research strategies, and finally present the results including a defense. |              |
| <b>Lehrveranstaltungsform</b>                                | Selbständige betreute Arbeit (30 SWS)                                                                                                                                                                                                                                                                          |              |
| <b>Unterrichtsprachen</b>                                    | Deutsch, Englisch                                                                                                                                                                                                                                                                                              |              |
| <b>Dauer in Semestern</b>                                    | 1 Semester Semester                                                                                                                                                                                                                                                                                            |              |
| <b>Angebotsrhythmus Modul</b>                                | jedes Semester                                                                                                                                                                                                                                                                                                 |              |
| <b>Aufnahmekapazität Modul</b>                               | unbegrenzt                                                                                                                                                                                                                                                                                                     |              |
| <b>Prüfungsebene</b>                                         |                                                                                                                                                                                                                                                                                                                |              |
| <b>Credit-Points</b>                                         | 30 CP                                                                                                                                                                                                                                                                                                          |              |
| <b>Modulabschlussnote</b>                                    | LV 1: %.                                                                                                                                                                                                                                                                                                       |              |
| <b>Faktor der Modulnote für die Endnote des Studiengangs</b> | 1                                                                                                                                                                                                                                                                                                              |              |
| Prüfung                                                      | Prüfungsvorleistung                                                                                                                                                                                                                                                                                            | Prüfungsform |
| <b>LV 1</b>                                                  |                                                                                                                                                                                                                                                                                                                |              |
| <b>Gesamtmodul</b>                                           | written Master-Thesis, oral defence                                                                                                                                                                                                                                                                            |              |
| <b>Wiederholungsprüfung</b>                                  |                                                                                                                                                                                                                                                                                                                |              |
| <b>Lehrveranstaltungsform</b>                                | Selbständige betreute Arbeit                                                                                                                                                                                                                                                                                   |              |
| <b>Veranstaltungstitel</b>                                   | Master Thesis                                                                                                                                                                                                                                                                                                  |              |
| <b>SWS</b>                                                   | 30                                                                                                                                                                                                                                                                                                             |              |
| <b>Workload Präsenz</b>                                      |                                                                                                                                                                                                                                                                                                                |              |
| <b>Workload Vor- / Nachbereitung</b>                         |                                                                                                                                                                                                                                                                                                                |              |
| <b>Workload selbstgestaltete Arbeit</b>                      |                                                                                                                                                                                                                                                                                                                |              |
| <b>Workload Prüfung incl. Vorbereitung</b>                   |                                                                                                                                                                                                                                                                                                                |              |
| <b>Workload insgesamt</b>                                    | 0                                                                                                                                                                                                                                                                                                              |              |
| <b>Workload selbstgestaltete Arbeit (modulbezogen)</b>       | 900                                                                                                                                                                                                                                                                                                            |              |
| <b>Workload Modul insgesamt</b>                              | 900                                                                                                                                                                                                                                                                                                            |              |
| <b>Prüfungsform</b>                                          |                                                                                                                                                                                                                                                                                                                |              |
| <b>Angebotsrhythmus</b>                                      | Sommersemester und Wintersemester                                                                                                                                                                                                                                                                              |              |
| <b>Aufnahmekapazität</b>                                     | unbegrenzt                                                                                                                                                                                                                                                                                                     |              |

## CHE.05558.02 - Introduction to Polymer Research

CHE.05558.02 15 CP

|                                               |                                                                                                                                                                                                                    |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Introduction to Polymer Research                                                                                                                                                                                   |
| <b>Modulcode</b>                              | CHE.05558.02                                                                                                                                                                                                       |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                    |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                    |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Dariush Hinderberger, Prof. Dr. Beate Langer                                                                                                                                                             |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                    |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                    |

- Students will be prepared for independent research.
- The project work is their first independent research experience.
- The students will learn to give a scientific presentation.
- They will become familiar with modern research topics in the field of polymers.

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulinhalte</b> | <p>This module covers advanced topics of polymer science and engineering. The lecture Polymer Colloquium is a ring lecture with local and guest lecturer presenting up to date information on their field of interest. The project work is the first way to perform an independent research at university or industry.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>Polymer Colloquium / Ring Lecture</li> </ol> <ul style="list-style-type: none"> <li>Introduction to database and literature research (block lecture)</li> <li>Modern methods and developments in polymer chemistry, physics and engineering</li> <li>New material developments</li> <li>Latest research activities by leading guest lecturers</li> <li>Activities in the local research groups (ring lecture)</li> <li>Interdisciplinary topics from adjacent fields</li> </ul> <p>Lab course:</p> <ol style="list-style-type: none"> <li>Lab course Project Work</li> </ol> <ul style="list-style-type: none"> <li>Participation in a research group at university or in industry</li> <li>Introduction to independent research</li> <li>Combining literature and experimental research</li> <li>Independent preparation of the research report</li> <li>Oral presentation of the results using PowerPoint</li> </ul> |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                              |                                                   |
|--------------------------------------------------------------|---------------------------------------------------|
| <b>Lehrveranstaltungsformen</b>                              | Vorlesung (1 SWS)<br>Praktikum (10 SWS)<br>Kursus |
| <b>Unterrichtsprachen</b>                                    | Deutsch, Englisch                                 |
| <b>Dauer in Semestern</b>                                    | 1 Semester Semester                               |
| <b>Angebotsrhythmus Modul</b>                                | jedes Wintersemester                              |
| <b>Aufnahmekapazität Modul</b>                               | unbegrenzt                                        |
| <b>Prüfungsebene</b>                                         |                                                   |
| <b>Credit-Points</b>                                         | 15 CP                                             |
| <b>Modulabschlussnote</b>                                    | LV 1: %; LV 2: %; LV 3: %.                        |
| <b>Faktor der Modulnote für die Endnote des Studiengangs</b> | 1                                                 |
| <b>Prüfung</b>                                               | Prüfungsvorleistung                               |
| <b>Prüfungsform</b>                                          |                                                   |
| <b>LV 1</b>                                                  |                                                   |
| <b>LV 2</b>                                                  |                                                   |

| Prüfung                  |                            |                                                    | Prüfungsvorleistung                    |                     |                                  | Prüfungsform                           |                                           |                   |
|--------------------------|----------------------------|----------------------------------------------------|----------------------------------------|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| LV 3                     |                            |                                                    |                                        |                     |                                  |                                        |                                           |                   |
| Gesamtmodul              |                            |                                                    |                                        |                     |                                  |                                        |                                           |                   |
|                          |                            |                                                    | oral presentation in the group seminar |                     |                                  | written examination (report)           |                                           |                   |
| Wiederholungsprüfung     |                            |                                                    |                                        |                     |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung   | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                            | SWS                                    | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                     | Vorlesung                  | Lecture<br>Polymer<br>Colloquium /<br>Ring Lecture |                                        | 1                   |                                  |                                        |                                           | 0                 |
| LV 2                     | Praktikum                  | Lab Course<br>Project Work                         |                                        | 10                  |                                  |                                        |                                           | 0                 |
| LV 3                     | Kursus                     | Private Study                                      |                                        |                     |                                  |                                        |                                           | 0                 |
| Workload modulbezogen    |                            |                                                    |                                        |                     |                                  | 450                                    |                                           | 450               |
| Workload Modul insgesamt |                            |                                                    |                                        |                     |                                  |                                        |                                           | 450               |

## CHE.05561.04 - Polymer Physical Chemistry

CHE.05561.04

10 CP

|                                               |                                                                                                                                                                                                                    |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Polymer Physical Chemistry                                                                                                                                                                                         |
| <b>Modulcode</b>                              | CHE.05561.04                                                                                                                                                                                                       |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                    |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                    |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Dariush Hinderberger                                                                                                                                                                                     |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                    |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                    |

- The students obtain basics of the physical chemistry of polymers and their characterization methods.
- The overview of analytical techniques for polymers enables the students for their practical application.
- They learn to perform basic polymer analyses using different techniques.
- Finally, they improve their capabilities in writing of scientific reports.

### Modulinhalte

This module covers basic topics of polymer physical chemistry. The lectures Instrumental Analytics of Polymers, Physical Chemistry and Polymer Characterization give an overview over the broad spectrum of characterization methods from different approaches. The lab courses Instrumental Analytics of Polymers Lab and Polymer Characterization Lab accompany the lectures and show the examples of the different characterization methods.

Lectures:

#### 1. Instrumental Analytics of Polymers

- Basic principles of analytical chemistry
- Statistical treatment of analytical data
- Special chromatographic techniques for the investigation of polymers and polymer additives
- Principles and instrumental parameters in molecule spectroscopy (IR- and Raman spectroscopy)
- Thermal analytical methods for the characterization of chemical and physical properties of polymers

#### 2. Physical Chemistry

- Phenomenological thermodynamics: Gibbs free energy, enthalpy, chemical potentials
- Chemical and phase equilibrium, thermodynamics of mixtures
- Chemical kinetics
- Basics of statistical thermodynamics

#### 3. Polymer Characterization

- Determination of molecular masses and distributions
- Thermodynamics of polymer solutions, colligative properties
- Viscosity and diffusion
- DSC, DMA, TMA
- Principles of chromatography
- Characterization of non-linear polymers
- Microstructure analysis by NMR
- Electrospray GC-MS, MALDI-TOF
- End-group titration

Lab courses:

#### 1. Instrumental Analytics of Polymers Lab e.g.

- Extraction of additives and analysis of extracts and residual monomers by GC/MS
- Elastomer characterization by TGA

- Qualitative analysis of polymers and copolymers by FTIR spectroscopy (MIR or NIR)
- Mn of polymers by vapour pressure osmometry or membrane osmometry

## 2. Polymer Characterization Lab e.g.

- static light scattering
- Dynamic light scattering
- Wide-angle X-ray scattering
- CMC determination
- Gel permeation chromatography (GPC/SEC)
- End-group titration
- Intrinsic viscosity
- Solubility of polymers
- Mass spectrometry of polymers (ESI and MALDI TOF)

|                                                       |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Lehrveranstaltungsformen                              |                            |                                                                                                                                                                                                                                                                                           |     | Vorlesung (1 SWS)<br>Praktikum (1 SWS)<br>Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Vorlesung (1 SWS)<br>Seminar (1 SWS)<br>Praktikum (2 SWS)<br>Kursus |                                                                                                    |                                        |                                           |                   |
| Unterrichtsprachen                                    |                            |                                                                                                                                                                                                                                                                                           |     | Deutsch, Englisch                                                                                                                                     |                                                                                                    |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                                                                                                                                                           |     | 2 Semester Semester                                                                                                                                   |                                                                                                    |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                                                                                                                                                           |     | jedes Wintersemester                                                                                                                                  |                                                                                                    |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                                                                                                                                                           |     | unbegrenzt                                                                                                                                            |                                                                                                    |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                                                                                                                                                           |     | 10 CP                                                                                                                                                 |                                                                                                    |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                                                                                                                                                           |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %; LV 7: %; LV 8: %.                                                                               |                                                                                                    |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                                                                                                                                           |     | 1                                                                                                                                                     |                                                                                                    |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                                                                                                                                                       |     |                                                                                                                                                       | Prüfungsform                                                                                       |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 7                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| LV 8                                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| Gesamtmodul                                           |                            | completed lab course protocols, written examination and seminar problem set solutions "Physical Chemistry", written examination and seminar problem set solutions "Polymer Characterization", written examination and completed lab course protocols "Instrumental Analytics of Polymers" |     |                                                                                                                                                       | oral or written examination (Instrumental Analytics, Physical Chemistry, Polymer Characterization) |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                       |                                                                                                    |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                                                                                                                                                   | SWS | Workload<br>Präsenz                                                                                                                                   | Workload Vor- /<br>Nachbereitung                                                                   | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Instrumental<br>Analytics of<br>Polymers                                                                                                                                                                                                                                       |     | 1                                                                                                                                                     |                                                                                                    |                                        |                                           | 0                 |
| LV 2                                                  | Praktikum                  | Lab course<br>Instrumental<br>Analytics of<br>Polymers                                                                                                                                                                                                                                    |     | 1                                                                                                                                                     |                                                                                                    |                                        |                                           | 0                 |

| Modulveranstalt<br>ung          | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                       | SWS | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
|---------------------------------|----------------------------|-----------------------------------------------|-----|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| <b>LV 3</b>                     | Vorlesung                  | Lecture<br>Physical<br>Chemistry              |     | 2                   |                                  |                                        |                                           | 0                 |
| <b>LV 4</b>                     | Seminar                    | Seminar<br>Physical<br>Chemistry              |     | 1                   |                                  |                                        |                                           | 0                 |
| <b>LV 5</b>                     | Vorlesung                  | Lecture<br>Polymer<br>Characterizatio<br>n    |     | 1                   |                                  |                                        |                                           | 0                 |
| <b>LV 6</b>                     | Seminar                    | Seminar<br>Polymer<br>Characterizatio<br>n    |     | 1                   |                                  |                                        |                                           | 0                 |
| <b>LV 7</b>                     | Praktikum                  | Lab course<br>Polymer<br>Characterizatio<br>n |     | 2                   |                                  |                                        |                                           | 0                 |
| <b>LV 8</b>                     | Kursus                     | Private study                                 |     |                     |                                  |                                        |                                           | 0                 |
| <b>Workload modulbezogen</b>    |                            |                                               |     |                     |                                  | 300                                    |                                           | 300               |
| <b>Workload Modul insgesamt</b> |                            |                                               |     |                     |                                  |                                        |                                           | 300               |

## PHY.05563.03 - Polymer Physics

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PHY.05563.03                                  | 10 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Modulbezeichnung</b>                       | Polymer Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Modulcode</b>                              | PHY.05563.03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Pflichtmodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Kay Saalwächter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>The students become acquainted with the fundamental concepts of experimental polymer physics.</li> <li>They learn and apply the theoretical fundamentals and the experimental physical methods used to characterize and investigate polymer materials.</li> <li>They gain practical experience with basic methods in experimental polymer physics.</li> <li>They will understand the properties of polymer surfaces.</li> <li>They receive the knowledge on methods and technologies to modify and analyze polymer surfaces.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Modulinhalte</b>                           | <p>This module covers basic topics of polymer physics. The lectures Introduction to Polymer Physics and Polymer Surface Science give an overview over the broad spectrum of physical aspects of polymeric samples. The lab course Polymer Physical Lab accompanies the lectures and show the examples of the different characterization methods.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>Introduction to Polymer Physics           <ul style="list-style-type: none"> <li>Structure of single chains (ideal vs. real chains, scattering, semidilute solutions and melts)</li> <li>Mechanical properties of polymers (liquids vs. solids, rubber elasticity, viscoelasticity, relaxation processes in polymer melts, Debye relaxation, flow behavior, time-temperature superposition and glass transition)</li> <li>Molecular structure and weight distributions (chemical structure, architecture, polymerization processes, determination of structures and molecular weights)</li> <li>Microscopic models for polymer dynamics (viscosity and diffusion, Rouse model, entanglements and reptation)</li> <li>Thermodynamics of solutions and melts (dilute and semidilute solutions, Flory-Huggins theory, kinetics of phase separation, block copolymers, semicrystalline polymers)</li> </ul> </li> <li>Polymer Surface Science           <ul style="list-style-type: none"> <li>Surface vs. bulk</li> <li>Surface composition and ordering</li> <li>Dynamic surface processes (adsorption, desorption, diffusion)</li> <li>Surface tension</li> <li>Surface analysis (XPS, SIMS, SEM, AFM)</li> <li>Surface modification by deposition (wet processes, dry processes, CVD, PE-CVD, PVD), polymer film growth</li> <li>Surface modification and functionalization (wet and dry etching, grafting, plasma treatment)</li> <li>Polymer in lithography</li> <li>Technical applications for surface modification</li> </ul> </li> </ol> <p>Lab course:</p> <ol style="list-style-type: none"> <li>Lab course Polymer Physical Lab e.g.           <ul style="list-style-type: none"> <li>Rheology/mechanical spectroscopy</li> <li>DSC</li> <li>Polarization microscopy</li> </ul> </li> </ol> |

|                                                       |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Lehrveranstaltungsformen                              |                            |                                                                                                                                                        |     | Vorlesung (3 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (1 SWS)<br>Seminar (1 SWS)<br>Kursus |                                  |                                        |                                           |                   |
| Unterrichtsprachen                                    |                            |                                                                                                                                                        |     | Deutsch, Englisch                                                                        |                                  |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                        |     | 1 Semester Semester                                                                      |                                  |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                        |     | jedes Sommersemester                                                                     |                                  |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                        |     | unbegrenzt                                                                               |                                  |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                        |     | 10 CP                                                                                    |                                  |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                        |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %.                                             |                                  |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                        |     | 1                                                                                        |                                  |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                    |     |                                                                                          | Prüfungsform                     |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| Gesamtmodul                                           |                            | completed lab course protocols, written examination and seminar problem set solutions `Polymer Physics`, written examination `Polymer Surface Science` |     |                                                                                          | oral examination                 |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                | SWS | Workload<br>Präsenz                                                                      | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Introduction to<br>Polymer<br>Physics                                                                                                       |     | 3                                                                                        |                                  |                                        |                                           | 0                 |
| LV 2                                                  | Vorlesung                  | Lecture<br>Polymer<br>Surface<br>Science                                                                                                               |     | 2                                                                                        |                                  |                                        |                                           | 0                 |
| LV 3                                                  | Praktikum                  | Lab Course<br>Polymer<br>Physics Lab                                                                                                                   |     | 1                                                                                        |                                  |                                        |                                           | 0                 |
| LV 4                                                  | Seminar                    | Seminar<br>Introduction to<br>Polymer<br>Physics                                                                                                       |     | 1                                                                                        |                                  |                                        |                                           | 0                 |
| LV 5                                                  | Kursus                     | Private study                                                                                                                                          |     |                                                                                          |                                  |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                        |     |                                                                                          |                                  | 300                                    |                                           | 300               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                        |     |                                                                                          |                                  |                                        |                                           | 300               |

# Polymer Engineering

## INW.05570.04 - Polymer Engineering Focus

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INW.05570.04                                  | 7 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Modulbezeichnung</b>                       | Polymer Engineering Focus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulcode</b>                              | INW.05570.04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Engineering</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr.-Ing. Maik Feldmann                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>The students acquire perspectives for the work as a polymer scientist or polymer engineer.</li> <li>They receive knowledge on applying polymers for different part specifications.</li> <li>The advanced knowledge on elastomeric materials enables them to work in industry.</li> <li>They obtain advanced knowledge on preparation and properties of elastomers.</li> <li>They can use their practical skills in polymer/elastomer preparation and characterization.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Modulinhalte</b>                           | <p>This module covers advanced topics of polymer engineering. The lectures Polymers in Industry and Elastomeric Materials connect the scientific approach to polymers with the industrial requirements and development methods. The lab course Elastomeric Materials Lab accompany the lectures and show the details of industrial processes. The research seminar deepens the view on industrial projects, which cannot be performed in a lab.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>Polymers in Industry<br/>Overview in application areas of polymers/thermoplastics and other materials in various components with respect to the industrial background. Specification and requirements for material and processing technology. Consideration of requirements and costs, overview of typical applications in various industries such as automotive, construction, packaging, electronics, recycling, and aerospace.</li> <li>Elastomeric Materials<br/>Structure, production, and properties of elastomeric materials; technical elastomers and their components (polymers, filler, crosslinking agents, additives), influence of additives on rheological and thermodynamic behavior, preparation of rubber mixtures, testing of elastomeric materials, damage analysis.</li> </ol> <p>Lab courses and Seminars:</p> <ol style="list-style-type: none"> <li>Elastomeric Materials Lab<br/>Content items: compounding of rubber mixtures, vulcanization, vulcametry, determination of mechanical properties of elastomeric materials</li> <li>Research Seminar<br/>Student presentation of research results from the literature from the polymer engineering field</li> </ol> |
| <b>Lehrveranstaltungsformen</b>               | Vorlesung (2 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (2 SWS)<br>Seminar (1 SWS)<br>Kursus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Unterrichtsprachen</b>                     | Deutsch, Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Dauer in Semestern</b>                     | 1 Semester Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Angebotsrhythmus Modul</b>                 | jedes Wintersemester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Aufnahmekapazität Modul</b>                | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Prüfungsebene</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

INW.05570.04

7 CP

|                                                       |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
|-------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|---|
| Credit-Points                                         |                            |                                                                                                                                                                   | 7 CP                                         |                     |                                  |                                        |                                           |                   |   |
| Modulabschlussnote                                    |                            |                                                                                                                                                                   | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %. |                     |                                  |                                        |                                           |                   |   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                   | 1                                            |                     |                                  |                                        |                                           |                   |   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                               |                                              |                     |                                  | Prüfungsform                           |                                           |                   |   |
| LV 1                                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| LV 2                                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| LV 3                                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| LV 4                                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| LV 5                                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| Gesamtmodul                                           |                            | completed lab course protocols, written examination (Polymers in Industry), written examination (Elastomeric Materials), seminar (Research seminar) participation |                                              |                     |                                  | oral examination (presentation)        |                                           |                   |   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           |                   |   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                           | SWS                                          | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |   |
| LV 1                                                  | Vorlesung                  | Lecture<br>Polymers in<br>Industry                                                                                                                                |                                              | 2                   |                                  |                                        |                                           |                   | 0 |
| LV 2                                                  | Vorlesung                  | Lecture<br>Elastomeric<br>Materials                                                                                                                               |                                              | 2                   |                                  |                                        |                                           |                   | 0 |
| LV 3                                                  | Praktikum                  | Lab course<br>Elastomeric<br>Materials                                                                                                                            |                                              | 2                   |                                  |                                        |                                           |                   | 0 |
| LV 4                                                  | Seminar                    | Research<br>Seminar                                                                                                                                               |                                              | 1                   |                                  |                                        |                                           |                   | 0 |
| LV 5                                                  | Kursus                     | Private study                                                                                                                                                     |                                              |                     |                                  |                                        |                                           |                   | 0 |
| Workload modulbezogen                                 |                            |                                                                                                                                                                   |                                              |                     |                                  | 210                                    |                                           | 210               |   |
| Workload Modul insgesamt                              |                            |                                                                                                                                                                   |                                              |                     |                                  |                                        |                                           | 210               |   |

## INW.05571.03 - Advanced Polymer Engineering

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INW.05571.03                                  | 10 CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Modulbezeichnung</b>                       | Advanced Polymer Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Modulcode</b>                              | INW.05571.03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Engineering</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Mario Beiner                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>Students acquire typical knowledge for the work as a polymer engineers.</li> <li>They receive advanced knowledge on processing polymer blends and composites.</li> <li>They will have practical skills for processing polymer blends and composites.</li> <li>Students can practically apply basic principles of advanced structure characterization techniques.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Modulinhalte</b>                           | <p>This module covers advanced methods of polymer processing (lecture 1: Processing of polymer blends and composites) and polymer characterization on macroscopic level (lecture 2: Polymer Structure and Morphology). The Lab courses Processing of polymer blends and composites and Polymer Structure and Morphology give the students the opportunity to perform their own polymer processing experiments and X-ray investigations.</p> <p>Lectures:</p> <ol style="list-style-type: none"> <li>Processing of polymer blends and composites <ul style="list-style-type: none"> <li>Techniques of modifying of polymers, creation of blends, compounds and master batches, compatibility and incompatibility of blends, special aspects of blend technology, influence of process parameters, technology of polymer composites: nano, micro and macro composites, manufacturing by different forms of composite components (particles, lamellas, short, long and endless fibers), special aspects of composites technology</li> </ul> </li> <li>Polymer Structure and Morphology <ul style="list-style-type: none"> <li>Scattering techniques: basic principles &amp; general aspects, primary scattering and interference, comparison x-rays and neutrons, radiation sources and detectors</li> <li>X-ray diffraction (WAXS): typical setups, diffraction by crystals, Braggs law and Laue condition, Miller indices, Structure factor and lattice factor, scattering of amorphous materials and liquids</li> <li>Small-angle X-ray scattering (SAXS): typical setups, application to semi-crystalline and self-assembled polymers, Guinier law and application to disordered systems</li> <li>Imaging techniques: light microscopy, atomic force microscopy, electron microscopy techniques</li> </ul> </li> </ol> <p>1. Lab Course: Processing of polymer blends and composites<br/>Practical exercises to special aspects by processing polymer blends and composites, Polymer orientation experiments after extrusion, effect of thermal treatment</p> <p>2. Lab Course: Polymer Structure and Morphology<br/>Practical exercises in imaging techniques, X-ray experiments with 1- and 2-dim detectors, AFM investigations on thin films</p> |
| <b>Lehrveranstaltungsformen</b>               | Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (2 SWS)<br>Praktikum (1 SWS)<br>Kursus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

INW.05571.03

10 CP

|                                                       |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Unterrichtsprachen                                    |                            |                                                                                                                                                 |     | Deutsch, Englisch                                     |                                                                         |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                 |     | 1 Semester Semester                                   |                                                                         |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                 |     | jedes Sommersemester                                  |                                                                         |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                 |     | unbegrenzt                                            |                                                                         |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                 |     | 10 CP                                                 |                                                                         |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                 |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %. |                                                                         |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                 |     | 1                                                     |                                                                         |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                             |     |                                                       | Prüfungsform                                                            |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| Gesamtmodul                                           |                            | completed lab course protocols (Processing of polymer blends and composites), completed lab course protocols (Polymer Structure and Morphology) |     |                                                       | oral or written examination (Processing of polymers, Polymer structure) |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                         | SWS | Workload<br>Präsenz                                   | Workload Vor- /<br>Nachbereitung                                        | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Processing of<br>polymer blends<br>and composites                                                                                    |     | 2                                                     |                                                                         |                                        |                                           | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Processing of<br>polymer blends<br>and composites                                                                                    |     | 1                                                     |                                                                         |                                        |                                           | 0                 |
| LV 3                                                  | Vorlesung                  | Lecture<br>Polymer<br>Structure and<br>Morphology                                                                                               |     | 2                                                     |                                                                         |                                        |                                           | 0                 |
| LV 4                                                  | Praktikum                  | Lab Processing<br>of polymer<br>blends and<br>composites                                                                                        |     | 2                                                     |                                                                         |                                        |                                           | 0                 |
| LV 5                                                  | Praktikum                  | Lab Polymer<br>Structure and<br>Morphology                                                                                                      |     | 1                                                     |                                                                         |                                        |                                           | 0                 |
| LV 6                                                  | Kursus                     | Private Study                                                                                                                                   |     |                                                       |                                                                         |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                 |     |                                                       |                                                                         | 300                                    |                                           | 300               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                 |     |                                                       |                                                                         |                                        |                                           | 300               |

## Polymer Science \*

### PHY.05568.05 - Polymer Science Focus

PHY.05568.05

7 CP

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Polymer Science Focus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Modulcode</b>                              | PHY.05568.05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Physics</li> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Science *</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Kay Saalwächter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>• The students become familiar with recent developments and modern research topics and methods in synthesis, characterization and properties of polymers and composite materials.</li> <li>• They learn to give a presentation based on literature work.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Modulinhalte</b>                           | <p>This module covers advanced topics of polymer physics and chemistry with state of the art examples. New approaches from literature and other groups will be presented and discussed. The research seminar deepens the view on new approaches.</p> <p>Lectures:</p> <p>1. Modern Concepts of Polymer and Biopolymer Synthesis<br/>Special topics in current synthetic polymer chemistry research:</p> <ul style="list-style-type: none"> <li>• Modern concepts of controlled and living polymerization techniques</li> <li>• Star block copolymers, dendrimers, hyper branched polymers, graft copolymers</li> <li>• Organic-inorganic hybrid materials</li> <li>• Polymerization in alternative reaction media (ionic liquids, supercritical solvents)</li> <li>• Click-chemistry, IPN, semi-IPN, graft polymerization</li> <li>• New industrially synthesized polymers (e.g., s-PS, s-PP)</li> <li>• Biochemical methods: enzymatic polymerizations</li> <li>• Modifications and degradation of biopolymers</li> <li>• Special analytical tools for the analysis of biopolymers</li> <li>• Biopolymer applications</li> </ul> <p>2. Modern Physical Polymer Science<br/>Special topics in current physical polymer research:</p> <ul style="list-style-type: none"> <li>• Block copolymers and polymer nanostructures</li> <li>• Crystallization of polymers</li> <li>• Nanocomposites</li> <li>• Polymer dynamics</li> <li>• Modern scattering techniques</li> <li>• Polymers in electronics and optics</li> <li>• Principles and applications of magnetic resonance techniques</li> </ul> <p>Seminar:</p> <p>1. Research seminar</p> <ul style="list-style-type: none"> <li>• Student presentation of research results from the literature from the fields of polymer chemistry of physics</li> </ul> |
| <b>Lehrveranstaltungsformen</b>               | <p>Vorlesung (2 SWS)</p> <p>Seminar (1 SWS)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

PHY.05568.05

7 CP

|                                                       |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
|                                                       |                            |                                                                                                                                                                                        |     | Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Kursus |                                  |                                        |                                           |                   |
| Unterrichtsprachen                                    |                            |                                                                                                                                                                                        |     | Deutsch, Englisch                                                 |                                  |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                                                        |     | 1 Semester Semester                                               |                                  |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                                                        |     | jedes Wintersemester                                              |                                  |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                                                        |     | unbegrenzt                                                        |                                  |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                                                        |     | 7 CP                                                              |                                  |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                                                        |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %.             |                                  |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                                        |     | 1                                                                 |                                  |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                                                    |     |                                                                   | Prüfungsform                     |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Gesamtmodul                                           |                            | oral or written examination Modern Concepts of Polymer and Biopolymer Synthesis, oral or written examination Modern Physical Polymer Science, seminar (Research seminar) participation |     |                                                                   | oral examination (presentation)  |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                                                | SWS | Workload<br>Präsenz                                               | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture Modern<br>Concepts of<br>Polymer and<br>Biopolymer<br>Synthesis                                                                                                                |     | 2                                                                 |                                  |                                        |                                           | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Modern<br>Concepts of<br>Polymer and<br>Biopolymer<br>Synthesis                                                                                                             |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 3                                                  | Vorlesung                  | Lecture Modern<br>Physical<br>Polymer<br>Science                                                                                                                                       |     | 2                                                                 |                                  |                                        |                                           | 0                 |
| LV 4                                                  | Seminar                    | Seminar<br>Modern<br>Physical<br>Polymer<br>Science                                                                                                                                    |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 5                                                  | Seminar                    | Research<br>seminar                                                                                                                                                                    |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 6                                                  | Kursus                     | Private study                                                                                                                                                                          |     |                                                                   |                                  |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                                                        |     |                                                                   |                                  | 210                                    |                                           | 210               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           | 210               |

## CHE.05564.06 - Advanced Polymer Chemistry

CHE.05564.06

10 CP

|                                               |                                                                                                                                                                                                                        |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Advanced Polymer Chemistry                                                                                                                                                                                             |
| <b>Modulcode</b>                              | CHE.05564.06                                                                                                                                                                                                           |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                        |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Science *</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                        |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Wolfgang Binder                                                                                                                                                                                              |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                        |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                        |

- Student gain fundamentals in advanced theoretical and practical knowledge of polymerization techniques.
- They will be enabled to carry out special living/controlled and catalytic polymerizations, enzymatic and biological polymer synthesis, and preparation of polymer/drug conjugates.
- They learn to use advanced characterization techniques and in vivo and in vitro testing of polymers.

### Modulinhalte

This module covers advanced methods of polymer synthesis (lecture 1: Advanced Polymer Synthesis) and polymer characterization on molecular level (lecture 2: Polymer Analytics). The Lab course Polymer Synthesis Lab gives the students the opportunity to perform their own syntheses.

Lecture:

#### 1. Advanced Polymer Synthesis

- Detailed description of standard polymerization techniques like living polymerization methods (CRP, LCCP, living anionic polymerization), ring opening polymerization ROP, ROMP), polymer analogous reactions for tailoring polymer properties, emulsion polymerization
- Detailed description of how to achieve advanced polymeric materials, variation of polymeric architectures, e.g., synthesis of block copolymers, grafted polymers, supramolecular polymers, vitrimers, polymers, design of shape memory polymers
- Polymers in energy engineering
- Polymer degradation and novel recycling methodologies
- Polymers and their use in microelectronics
- Polymers and their application in medicine
- Biopolymers, their biosynthesis and their technological use.
- Description of the main analytical techniques in polymer science, with a detailed study of NMR, GPC and MS techniques, discussion of practical application of techniques to polymer molecules

#### 2. Polymer Analytics

- Description and practical experience in thermal, mechanical and stability-analysis of polymers (DSC, TGA, DTMA, melt-rheology).
- NMR-spectroscopy: solution NMR, basic techniques, sensitivity, heteronuclear-NMR, basic 2D-techniques, relaxation in macromolecules, training and discussion of chemical shift analysis, spin/spin-coupling patterns, coupling constants in relation to chemical structure, isotopic patterns and molecular weight, determination of exact chemical structures, discussion of 2D-COSY-spectroscopy and practical analysis
- MS-analytical methods (MALDI-TOF; ESI-TOF; TOF/TOF) for the analytics of synthetic and biopolymers
- Advanced GPC/HPLC chromatography: 2D-methods in relation to polarity and coupling techniques, influence of solvents and columns, interpretation of elution times

Lab course:

#### 1. Polymer Synthesis Lab

- Independent personal execution of polymerization experiments. The

method (Ionic polymerization, Living polymerization (ATRP, NMP, LCCP)) will vary due to lab capacity.

- Multiple step polymerization techniques are performed, e.g. to obtain polymers with special magnetic and electric properties, solution properties, or general block copolymers
- Analytics of polymers (structural analytics and materials analytics such as NMR, MS-, SEC, TGA, DSC, melt-rheology, 3D printing)

|                                                       |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
|-------------------------------------------------------|----------------------------|---------------------------------------------|-----|-------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------|-----------------------------------------------------------------------------|-------------------|
| Lehrveranstaltungsformen                              |                            |                                             |     | Vorlesung (1 SWS)<br>Seminar (1 SWS)<br>Praktikum (5 SWS)<br>Vorlesung (1 SWS)<br>Kursus  |                                  |                                        |                                                                             |                   |
| Unterrichtsprachen                                    |                            |                                             |     | Deutsch, Englisch                                                                         |                                  |                                        |                                                                             |                   |
| Dauer in Semestern                                    |                            |                                             |     | 1 Semester Semester                                                                       |                                  |                                        |                                                                             |                   |
| Angebotsrhythmus Modul                                |                            |                                             |     | jedes Sommersemester                                                                      |                                  |                                        |                                                                             |                   |
| Aufnahmekapazität Modul                               |                            |                                             |     | unbegrenzt                                                                                |                                  |                                        |                                                                             |                   |
| Prüfungsebene                                         |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| Credit-Points                                         |                            |                                             |     | 10 CP                                                                                     |                                  |                                        |                                                                             |                   |
| Modulabschlussnote                                    |                            |                                             |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %.                                              |                                  |                                        |                                                                             |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                             |     | 1                                                                                         |                                  |                                        |                                                                             |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                         |     |                                                                                           | Prüfungsform                     |                                        |                                                                             |                   |
| LV 1                                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| LV 2                                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| LV 3                                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| LV 4                                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| LV 5                                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| Gesamtmodul                                           |                            |                                             |     | completed lab course protocols and lab-safety examinations, seminar problem set solutions |                                  |                                        | oral or written examination (Advanced Polymer Synthesis, Polymer Analytics) |                   |
| Wiederholungsprüfung                                  |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                     | SWS | Workload<br>Präsenz                                                                       | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung                                   | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture<br>Advanced<br>Polymer<br>Synthesis |     | 1                                                                                         |                                  |                                        |                                                                             | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Advanced<br>Polymer<br>Synthesis |     | 1                                                                                         |                                  |                                        |                                                                             | 0                 |
| LV 3                                                  | Praktikum                  | Lab course<br>Polymer<br>Synthesis          |     | 5                                                                                         |                                  |                                        |                                                                             | 0                 |
| LV 4                                                  | Vorlesung                  | Lecture<br>Polymer<br>Analytics             |     | 1                                                                                         |                                  |                                        |                                                                             | 0                 |
| LV 5                                                  | Kursus                     | Private study                               |     |                                                                                           |                                  |                                        |                                                                             | 0                 |
| Workload modulbezogen                                 |                            |                                             |     |                                                                                           |                                  | 300                                    |                                                                             | 300               |
| Workload Modul insgesamt                              |                            |                                             |     |                                                                                           |                                  |                                        |                                                                             | 300               |

## PHY.05566.05 - Advanced Polymer Physics

PHY.05566.05

10 CP

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Advanced Polymer Physics                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulcode</b>                              | PHY.05566.05                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Physics</li> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Science *</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Kay Saalwächter                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                        |

- The students deepen their background knowledge in polymer physics.
- They will be familiar with fundamental principles of soft-matter physics.
- They gain experience in advanced concepts of experimental or theoretical polymer physics.

### Modulinhalte

This module covers advanced experimental and theoretical details of polymer physics. Beside basic lecture (Soft Condensed Matter Physics), the students can focus on either experimental (Polymer Structure and Morphology) or more theoretical approaches (Polymer Theory). The Lab courses Advanced Polymer Physics Lab and Polymer Structure and Morphology give the students the opportunity to perform their own characterization experiments.

Lectures:

#### 1. Soft Condensed Matter Physics

- Structure and dynamics of liquids (existence, pair correlation function, glass transition)
- Liquid crystals (classification, structure and defects in nematics, nematic-to-isotropic phase transition, elastic properties and Fredericks-transition)
- Surfactants: supramolecular structures and self-organization (micelles and membranes)
- Colloidal dispersions: heterogeneous systems (Brownian motion, forces between colloids, colloidal phase transitions)
- Polymers (conformations: ideal chains, rubber elasticity, introduction into semicrystalline polymers)

#### 2a. (either) Polymer Structure and Morphology

- Scattering techniques: basic principles & general aspects, primary scattering and interference, comparison x-rays and neutrons, radiation sources and detectors
- X-ray diffraction (WAXS): typical setups, diffraction by crystals, Braggs law and Laue condition, Miller indices, Structure factor and lattice factor, scattering of amorphous materials and liquids
- Small-angle X-ray scattering (SAXS): typical setups, application to semi-crystalline and self-assembled polymers, Guinier law and application to disordered systems
- Imaging techniques: light microscopy, atomic force microscopy, electron microscopy techniques

#### 2b. (or) Polymer Theory

- Conformational statistics of polymers
- Flory-Huggins theory for solutions and blends
- Self-consistent field theory
- Random phase approximation
- Polymer networks
- Scaling theory of polymers
- Theories of polymer dynamics

## Lab courses:

## 1. Advanced Polymer Physics Lab

- Experiments using special techniques for physical structure details: Dielectric spectroscopy, low-field NMR, light microscopy, atomic force microscopy, X-ray scattering

## 2. (optional) Polymer Structure and Morphology

- Practical exercises in imaging techniques, X-ray experiments with 1- and 2-dim detectors, AFM investigations on thin films
- Practical exercises in imaging techniques

|                                                       |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
|-------------------------------------------------------|------------------------|---------------------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|-------------------------------------------------------------------------------------|----------------|---|
| Lehrveranstaltungsformen                              |                        |                                       |     | Vorlesung (3 SWS)<br>Vorlesung (3 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Praktikum (1 SWS)<br>Praktikum (1 SWS)<br>Vorlesung (2 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (1 SWS)<br>Seminar (1 SWS)<br>Kursus<br>Kursus |                               |                                  |                                                                                     |                |   |
| Unterrichtsprachen                                    |                        |                                       |     | Deutsch, Englisch                                                                                                                                                                                                            |                               |                                  |                                                                                     |                |   |
| Dauer in Semestern                                    |                        |                                       |     | 1 Semester Semester                                                                                                                                                                                                          |                               |                                  |                                                                                     |                |   |
| Angebotsrhythmus Modul                                |                        |                                       |     | jedes Sommersemester                                                                                                                                                                                                         |                               |                                  |                                                                                     |                |   |
| Aufnahmekapazität Modul                               |                        |                                       |     | unbegrenzt                                                                                                                                                                                                                   |                               |                                  |                                                                                     |                |   |
| Prüfungsebene                                         |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| Credit-Points                                         |                        |                                       |     | 10 CP                                                                                                                                                                                                                        |                               |                                  |                                                                                     |                |   |
| Modulabschlussnote                                    |                        |                                       |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %; LV 7: %; LV 8: %; LV 9: %; LV 10: %; LV 11: %; LV 12: %.                                                                                                               |                               |                                  |                                                                                     |                |   |
| Faktor der Modulnote für die Endnote des Studiengangs |                        |                                       |     | 1                                                                                                                                                                                                                            |                               |                                  |                                                                                     |                |   |
| Prüfung                                               |                        | Prüfungsvorleistung                   |     |                                                                                                                                                                                                                              | Prüfungsform                  |                                  |                                                                                     |                |   |
| LV 1                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 2                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 3                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 4                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 5                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 6                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 7                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 8                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 9                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 10                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 11                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| LV 12                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| Gesamtmodul                                           |                        |                                       |     | completed lab course protocols, seminar (Soft Condensed Matter Physics) problem set solutions                                                                                                                                |                               |                                  | oral or written examination (Condensed Matter, Polymer Theory or Polymer Structure) |                |   |
| Wiederholungsprüfung                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |   |
| Modulveranstaltung                                    | Lehrveranstaltungsform | Veranstaltungstitel                   | SWS | Workload Präsenz                                                                                                                                                                                                             | Workload Vor- / Nachbereitung | Workload selbstgestaltete Arbeit | Workload Prüfung incl. Vorbereitung                                                 | Workload Summe |   |
| LV 1                                                  | Vorlesung              | Lecture Soft Condensed Matter Physics |     | 3                                                                                                                                                                                                                            |                               |                                  |                                                                                     |                | 0 |
| LV 2                                                  | Vorlesung              | Lecture Soft Condensed                |     | 3                                                                                                                                                                                                                            |                               |                                  |                                                                                     |                | 0 |

| Modulveranstalt<br>ung          | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                             | SWS | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
|---------------------------------|----------------------------|-----------------------------------------------------|-----|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
|                                 |                            | Matter Physics                                      |     |                     |                                  |                                        |                                           |                   |
| LV 3                            | Seminar                    | Seminar Soft<br>Condensed<br>Matter Physics         |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 4                            | Seminar                    | Seminar Soft<br>Condensed<br>Matter Physics         |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 5                            | Praktikum                  | Lab course<br>Advanced<br>Polymer<br>Physics        |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 6                            | Praktikum                  | Lab Course<br>Advanced<br>Poly.Phys. Lab            |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 7                            | Vorlesung                  | Lecture<br>Polymer<br>Structure and<br>Morphology   |     | 2                   |                                  |                                        |                                           | 0                 |
| LV 8                            | Vorlesung                  | Lecture<br>Polymer Theory                           |     | 2                   |                                  |                                        |                                           | 0                 |
| LV 9                            | Praktikum                  | LabCourse<br>Polymer<br>Structure and<br>Morphology |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 10                           | Seminar                    | Seminar<br>Polymer Theory                           |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 11                           | Kursus                     | Private study                                       |     |                     |                                  |                                        |                                           | 0                 |
| LV 12                           | Kursus                     | Private study                                       |     |                     |                                  |                                        |                                           | 0                 |
| <b>Workload modulbezogen</b>    |                            |                                                     |     |                     |                                  | 300                                    |                                           | 300               |
| <b>Workload Modul insgesamt</b> |                            |                                                     |     |                     |                                  |                                        |                                           | 300               |

# Polymer Physics

## PHY.05568.05 - Polymer Science Focus

PHY.05568.05

7 CP

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Polymer Science Focus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Modulcode</b>                              | PHY.05568.05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Physics</li> <li>Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Science *</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Kay Saalwächter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Kompetenzziele</b>                         | <ul style="list-style-type: none"> <li>The students become familiar with recent developments and modern research topics and methods in synthesis, characterization and properties of polymers and composite materials.</li> <li>They learn to give a presentation based on literature work.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Modulinhalte</b>                           | <p>This module covers advanced topics of polymer physics and chemistry with state of the art examples. New approaches from literature and other groups will be presented and discussed. The research seminar deepens the view on new approaches.</p> <p>Lectures:</p> <p>1. Modern Concepts of Polymer and Biopolymer Synthesis<br/>Special topics in current synthetic polymer chemistry research:</p> <ul style="list-style-type: none"> <li>Modern concepts of controlled and living polymerization techniques</li> <li>Star block copolymers, dendrimers, hyper branched polymers, graft copolymers</li> <li>Organic-inorganic hybrid materials</li> <li>Polymerization in alternative reaction media (ionic liquids, supercritical solvents)</li> <li>Click-chemistry, IPN, semi-IPN, graft polymerization</li> <li>New industrially synthesized polymers (e.g., s-PS, s-PP)</li> <li>Biochemical methods: enzymatic polymerizations</li> <li>Modifications and degradation of biopolymers</li> <li>Special analytical tools for the analysis of biopolymers</li> <li>Biopolymer applications</li> </ul> <p>2. Modern Physical Polymer Science<br/>Special topics in current physical polymer research:</p> <ul style="list-style-type: none"> <li>Block copolymers and polymer nanostructures</li> <li>Crystallization of polymers</li> <li>Nanocomposites</li> <li>Polymer dynamics</li> <li>Modern scattering techniques</li> <li>Polymers in electronics and optics</li> <li>Principles and applications of magnetic resonance techniques</li> </ul> <p>Seminar:</p> <p>1. Research seminar</p> <ul style="list-style-type: none"> <li>Student presentation of research results from the literature from the fields of polymer chemistry of physics</li> </ul> |
| <b>Lehrveranstaltungsformen</b>               | <p>Vorlesung (2 SWS)</p> <p>Seminar (1 SWS)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

PHY.05568.05

7 CP

|                                                       |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
|-------------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
|                                                       |                            |                                                                                                                                                                                        |     | Vorlesung (2 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Kursus |                                  |                                        |                                           |                   |
| Unterrichtsprachen                                    |                            |                                                                                                                                                                                        |     | Deutsch, Englisch                                                 |                                  |                                        |                                           |                   |
| Dauer in Semestern                                    |                            |                                                                                                                                                                                        |     | 1 Semester Semester                                               |                                  |                                        |                                           |                   |
| Angebotsrhythmus Modul                                |                            |                                                                                                                                                                                        |     | jedes Wintersemester                                              |                                  |                                        |                                           |                   |
| Aufnahmekapazität Modul                               |                            |                                                                                                                                                                                        |     | unbegrenzt                                                        |                                  |                                        |                                           |                   |
| Prüfungsebene                                         |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Credit-Points                                         |                            |                                                                                                                                                                                        |     | 7 CP                                                              |                                  |                                        |                                           |                   |
| Modulabschlussnote                                    |                            |                                                                                                                                                                                        |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %.             |                                  |                                        |                                           |                   |
| Faktor der Modulnote für die Endnote des Studiengangs |                            |                                                                                                                                                                                        |     | 1                                                                 |                                  |                                        |                                           |                   |
| Prüfung                                               |                            | Prüfungsvorleistung                                                                                                                                                                    |     |                                                                   | Prüfungsform                     |                                        |                                           |                   |
| LV 1                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 2                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 3                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 4                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 5                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| LV 6                                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Gesamtmodul                                           |                            | oral or written examination Modern Concepts of Polymer and Biopolymer Synthesis, oral or written examination Modern Physical Polymer Science, seminar (Research seminar) participation |     |                                                                   | oral examination (presentation)  |                                        |                                           |                   |
| Wiederholungsprüfung                                  |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           |                   |
| Modulveranstalt<br>ung                                | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                                                                                                                                                                | SWS | Workload<br>Präsenz                                               | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
| LV 1                                                  | Vorlesung                  | Lecture Modern<br>Concepts of<br>Polymer and<br>Biopolymer<br>Synthesis                                                                                                                |     | 2                                                                 |                                  |                                        |                                           | 0                 |
| LV 2                                                  | Seminar                    | Seminar<br>Modern<br>Concepts of<br>Polymer and<br>Biopolymer<br>Synthesis                                                                                                             |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 3                                                  | Vorlesung                  | Lecture Modern<br>Physical<br>Polymer<br>Science                                                                                                                                       |     | 2                                                                 |                                  |                                        |                                           | 0                 |
| LV 4                                                  | Seminar                    | Seminar<br>Modern<br>Physical<br>Polymer<br>Science                                                                                                                                    |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 5                                                  | Seminar                    | Research<br>seminar                                                                                                                                                                    |     | 1                                                                 |                                  |                                        |                                           | 0                 |
| LV 6                                                  | Kursus                     | Private study                                                                                                                                                                          |     |                                                                   |                                  |                                        |                                           | 0                 |
| Workload modulbezogen                                 |                            |                                                                                                                                                                                        |     |                                                                   |                                  | 210                                    |                                           | 210               |
| Workload Modul insgesamt                              |                            |                                                                                                                                                                                        |     |                                                                   |                                  |                                        |                                           | 210               |

## PHY.05566.05 - Advanced Polymer Physics

PHY.05566.05

10 CP

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>                       | Advanced Polymer Physics                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modulcode</b>                              | PHY.05566.05                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Semester der erstmaligen Durchführung</b>  |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Verwendet in Studiengängen / Semestern</b> | <ul style="list-style-type: none"> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Physics</li> <li>• Polymer Materials Science (MA120 LP) (Master) &gt; Materialwissenschaft PolymerMaterialScMA120, . Akkreditierungsfassung gültig ab WS 2014/15 &gt; Polymer Science *</li> </ul> |
| <b>Modulverantwortliche/r</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Weitere verantwortliche Personen</b>       | Prof. Dr. Kay Saalwächter                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Teilnahmevoraussetzungen</b>               |                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Kompetenzziele</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                        |

- The students deepen their background knowledge in polymer physics.
- They will be familiar with fundamental principles of soft-matter physics.
- They gain experience in advanced concepts of experimental or theoretical polymer physics.

### Modulinhalte

This module covers advanced experimental and theoretical details of polymer physics. Beside basic lecture (Soft Condensed Matter Physics), the students can focus on either experimental (Polymer Structure and Morphology) or more theoretical approaches (Polymer Theory). The Lab courses Advanced Polymer Physics Lab and Polymer Structure and Morphology give the students the opportunity to perform their own characterization experiments.

Lectures:

#### 1. Soft Condensed Matter Physics

- Structure and dynamics of liquids (existence, pair correlation function, glass transition)
- Liquid crystals (classification, structure and defects in nematics, nematic-to-isotropic phase transition, elastic properties and Fredericks-transition)
- Surfactants: supramolecular structures and self-organization (micelles and membranes)
- Colloidal dispersions: heterogeneous systems (Brownian motion, forces between colloids, colloidal phase transitions)
- Polymers (conformations: ideal chains, rubber elasticity, introduction into semicrystalline polymers)

#### 2a. (either) Polymer Structure and Morphology

- Scattering techniques: basic principles & general aspects, primary scattering and interference, comparison x-rays and neutrons, radiation sources and detectors
- X-ray diffraction (WAXS): typical setups, diffraction by crystals, Braggs law and Laue condition, Miller indices, Structure factor and lattice factor, scattering of amorphous materials and liquids
- Small-angle X-ray scattering (SAXS): typical setups, application to semi-crystalline and self-assembled polymers, Guinier law and application to disordered systems
- Imaging techniques: light microscopy, atomic force microscopy, electron microscopy techniques

#### 2b. (or) Polymer Theory

- Conformational statistics of polymers
- Flory-Huggins theory for solutions and blends
- Self-consistent field theory
- Random phase approximation
- Polymer networks
- Scaling theory of polymers
- Theories of polymer dynamics

## Lab courses:

## 1. Advanced Polymer Physics Lab

- Experiments using special techniques for physical structure details: Dielectric spectroscopy, low-field NMR, light microscopy, atomic force microscopy, X-ray scattering

## 2. (optional) Polymer Structure and Morphology

- Practical exercises in imaging techniques, X-ray experiments with 1- and 2-dim detectors, AFM investigations on thin films
- Practical exercises in imaging techniques

|                                                       |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
|-------------------------------------------------------|------------------------|---------------------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|-------------------------------------------------------------------------------------|----------------|
| Lehrveranstaltungsformen                              |                        |                                       |     | Vorlesung (3 SWS)<br>Vorlesung (3 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Praktikum (1 SWS)<br>Praktikum (1 SWS)<br>Vorlesung (2 SWS)<br>Vorlesung (2 SWS)<br>Praktikum (1 SWS)<br>Seminar (1 SWS)<br>Kursus<br>Kursus |                               |                                  |                                                                                     |                |
| Unterrichtsprachen                                    |                        |                                       |     | Deutsch, Englisch                                                                                                                                                                                                            |                               |                                  |                                                                                     |                |
| Dauer in Semestern                                    |                        |                                       |     | 1 Semester Semester                                                                                                                                                                                                          |                               |                                  |                                                                                     |                |
| Angebotsrhythmus Modul                                |                        |                                       |     | jedes Sommersemester                                                                                                                                                                                                         |                               |                                  |                                                                                     |                |
| Aufnahmekapazität Modul                               |                        |                                       |     | unbegrenzt                                                                                                                                                                                                                   |                               |                                  |                                                                                     |                |
| Prüfungsebene                                         |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| Credit-Points                                         |                        |                                       |     | 10 CP                                                                                                                                                                                                                        |                               |                                  |                                                                                     |                |
| Modulabschlussnote                                    |                        |                                       |     | LV 1: %; LV 2: %; LV 3: %; LV 4: %; LV 5: %; LV 6: %; LV 7: %; LV 8: %; LV 9: %; LV 10: %; LV 11: %; LV 12: %.                                                                                                               |                               |                                  |                                                                                     |                |
| Faktor der Modulnote für die Endnote des Studiengangs |                        |                                       |     | 1                                                                                                                                                                                                                            |                               |                                  |                                                                                     |                |
| Prüfung                                               |                        | Prüfungsvorleistung                   |     |                                                                                                                                                                                                                              | Prüfungsform                  |                                  |                                                                                     |                |
| LV 1                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 2                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 3                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 4                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 5                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 6                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 7                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 8                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 9                                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 10                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 11                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| LV 12                                                 |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| Gesamtmodul                                           |                        |                                       |     | completed lab course protocols, seminar (Soft Condensed Matter Physics) problem set solutions                                                                                                                                |                               |                                  | oral or written examination (Condensed Matter, Polymer Theory or Polymer Structure) |                |
| Wiederholungsprüfung                                  |                        |                                       |     |                                                                                                                                                                                                                              |                               |                                  |                                                                                     |                |
| Modulveranstaltung                                    | Lehrveranstaltungsform | Veranstaltungstitel                   | SWS | Workload Präsenz                                                                                                                                                                                                             | Workload Vor- / Nachbereitung | Workload selbstgestaltete Arbeit | Workload Prüfung incl. Vorbereitung                                                 | Workload Summe |
| LV 1                                                  | Vorlesung              | Lecture Soft Condensed Matter Physics |     | 3                                                                                                                                                                                                                            |                               |                                  |                                                                                     | 0              |
| LV 2                                                  | Vorlesung              | Lecture Soft Condensed                |     | 3                                                                                                                                                                                                                            |                               |                                  |                                                                                     | 0              |

| Modulveranstalt<br>ung          | Lehrveranstaltu<br>ngsform | Veranstaltungsti<br>tel                             | SWS | Workload<br>Präsenz | Workload Vor- /<br>Nachbereitung | Workload<br>selbstgestaltete<br>Arbeit | Workload<br>Prüfung incl.<br>Vorbereitung | Workload<br>Summe |
|---------------------------------|----------------------------|-----------------------------------------------------|-----|---------------------|----------------------------------|----------------------------------------|-------------------------------------------|-------------------|
| Matter Physics                  |                            |                                                     |     |                     |                                  |                                        |                                           |                   |
| LV 3                            | Seminar                    | Seminar Soft<br>Condensed<br>Matter Physics         |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 4                            | Seminar                    | Seminar Soft<br>Condensed<br>Matter Physics         |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 5                            | Praktikum                  | Lab course<br>Advanced<br>Polymer<br>Physics        |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 6                            | Praktikum                  | Lab Course<br>Advanced<br>Poly.Phys. Lab            |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 7                            | Vorlesung                  | Lecture<br>Polymer<br>Structure and<br>Morphology   |     | 2                   |                                  |                                        |                                           | 0                 |
| LV 8                            | Vorlesung                  | Lecture<br>Polymer Theory                           |     | 2                   |                                  |                                        |                                           | 0                 |
| LV 9                            | Praktikum                  | LabCourse<br>Polymer<br>Structure and<br>Morphology |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 10                           | Seminar                    | Seminar<br>Polymer Theory                           |     | 1                   |                                  |                                        |                                           | 0                 |
| LV 11                           | Kursus                     | Private study                                       |     |                     |                                  |                                        |                                           | 0                 |
| LV 12                           | Kursus                     | Private study                                       |     |                     |                                  |                                        |                                           | 0                 |
| <b>Workload modulbezogen</b>    |                            |                                                     |     |                     |                                  | 300                                    |                                           | 300               |
| <b>Workload Modul insgesamt</b> |                            |                                                     |     |                     |                                  |                                        |                                           | 300               |

