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|--------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>Modulbezeichnung:</b> | <b>Molecular nanoscience (MSM-nano)</b><br>(Molecular nanoscience)                                                       | <b>30 ECTS</b>               |
| Modulverantwortliche/r:  | Andreas Hirsch                                                                                                           |                              |
| Lehrende:                | Rainer Fink, Milan Kivala, Dirk Guldi, Julien Bachmann, Andreas Hirsch, Jürgen Schatz, Hubertus Marbach, Franziska Gröhn |                              |
| Startsemester:           | SS 2018                                                                                                                  | Dauer: 2 Semester            |
| Präsenzzeit:             | 450 Std.                                                                                                                 | Eigenstudium: 450 Std.       |
|                          |                                                                                                                          | Turnus: halbjährlich (WS+SS) |
|                          |                                                                                                                          | Sprache: Englisch            |

#### Lehrveranstaltungen:

##### **Mandatory courses (A): Lectures & Seminars:**

A1: Supramolecular Chemistry I (2L) & II (2L)

A2: Nanoparticles and nanostructured thin films I (1L) & II (1L)

A3: Nanoprobes I (2L) & II (2L)

A4: Molecular Nanoscience SEMINAR I (2S) & SEMINAR II (2S)

A5: LAB COURSE Molecular Nanoscience (7LAB)

Supramolecular Chemistry - Molecular Materials II (SS 2018, Vorlesung, 2 SWS, Andreas Hirsch)

Supramolecular Chemistry I / Molekulare Materialien I, Supramolekulare Chemie I (WS 2018/2019, Vorlesung, 2 SWS, Andreas Hirsch et al.)

Nanoparticles and Nanostructured Thin Films / Nanopartikel und nanostrukturierte dünne Schichten (WS 2018/2019, Vorlesung, 2 SWS, Julien Bachmann)

Nanoprobes I (WS 2018/2019, Vorlesung, 2 SWS, Rainer Fink)

Nanoprobes II (SS 2018, Vorlesung, 2 SWS, Rainer Fink)

Seminar Molecular Nanoscience II (SS 2018, Seminar, 2 SWS, Franziska Gröhn et al.)

Seminar Molecular Nanoscience I (WS 2018/2019, Seminar, 2 SWS, Franziska Gröhn et al.)

Lab Course Molecular Nanoscience/Molecular Materials (SS 2018, Praktikum, 7 SWS, Rainer Fink et al.)

##### **Elective courses (B) (in total 9 SWS\*):**

Courses of the student's choice related to the module and with approval by the representative of the study course

- choose a minimum of 4 lectures (2L each) and 1 seminar (1S)**

B1: Characterization of nanosized systems (2L)

B2: Organic thin films (2L/1S)

B3: Formation and characterization of supramolecular nanostructures (2L/2S)

B4: Carbon allotropes - synthesis, properties and applications (2L/2S)

B5: Nanoscale semiconductor materials (2L)

B6: Modern techniques in surface science (2L/2S)

B7: Metallic Nanoparticles in medicine

Characterization of Nanosized Systems (WS 2018/2019, Vorlesung, 2 SWS, Dirk Guldi)

Organic Thin Films (WS 2018/2019, Vorlesung, 2 SWS, Rainer Fink)

Seminar Organic Thin Films (WS 2018/2019, Seminar, 1 SWS, Rainer Fink et al.)

Formation and Characterization of Supramolecular Nanoparticles (WS 2018/2019, Vorlesung, 2 SWS, Franziska Gröhn)

Seminar Formation and Characterization of Supramolecular Nanoparticles (WS 2018/2019, Seminar, 1 SWS, Franziska Gröhn et al.)

Carbon Allotropes: Synthesis, Properties and Application (SS 2018, Vorlesung, 2 SWS, N.N.)

Nanoscale semiconductors (SS 2018, Vorlesung, 2 SWS, Julien Bachmann)

Modern Techniques in Surface Science (SS 2018, Vorlesung, 2 SWS, Christian Papp et al.)

Seminar Modern Techniques in Surface Science (SS 2018, Seminar, 1 SWS, Christian Papp et al.)

Metallic Nanoparticles in Medicine (SS 2018, Vorlesung, 2 SWS, Carola Krysch)

#### Empfohlene Voraussetzungen:

Admission to the M. Sc. program Molecular Science or Chemistry

#### Inhalt:

**A1:** Concepts in supramolecular chemistry; host-guest chemistry; energetics of supramolecular complexes: experimental methods; templates and self-assembly. Molecular devices. Supramolecular catalysis:

principles of supramolecular catalysis, supramolecular metal catalysis, self-assembled catalysts, metal-free catalysis, enzyme mimics, antibodies, imprinted polymers.

**A2:** Synthesis of n-dimensional nano-materials. Systematic approaches towards nano-particles of defined size and structure are the basis to prepare materials with tailor-made electronic, optical or catalytic properties. The interplay between nano-particles, nano-rods, nano-wires, 2- and 3-dimensional materials are highlighted.

**A3:** Nanoscaled systems, general issues of microscopic techniques; experimental techniques with nanometer resolution: STM/AFM and 8 related scanning probes; light microscopy, confocal microscopy; electron microscopy (SEM, TEM, FEM/FIM, LEEM, PEEM), x-ray microscopy and synchrotron radiation.

**A4:** Specific topics in synthesis and analysis of specific molecule-based nanoscale objects

**A5:** focused topics in fundamental and applied research on nanoscale materials

### **Lernziele und Kompetenzen:**

The students are able

- to explain the fundamental chemical and physical properties of nano-scale materials
- to distinguish and to compare some properties, structure and applications of different nanomaterials
- to describe and to evaluate the major concepts in supramolecular chemistry
- to explain the general issues of selected microscopic techniques and to evaluate their applications to different materials
- to prepare and to characterize nano-sized samples (thin films, nano-tubes, molecular materials, nanoparticles) using selected experimental methods and techniques (includes experiment planning and data evaluation)
- to interpret and to critically summarize measurements results in written (lab report in paper-style format) and partly oral form
- to get used to perform research-related experiments within a smaller team.

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### **Verwendbarkeit des Moduls / Einpassung in den Musterstudienplan:**

Das Modul ist im Kontext der folgenden Studienfächer/Vertiefungsrichtungen verwendbar:

#### **[1] Molecular Science (Master of Science)**

(Po-Vers. 2013 | NatFak | Molecular Science (Master of Science) | Pflichtmodul Molecular Science)

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### **Studien-/Prüfungsleistungen:**

Molecular Nanoscience (Prüfungsnummer: 30701)

(englische Bezeichnung: Molecular Nanoscience)

Prüfungsleistung, mündliche Prüfung, Dauer (in Minuten): 45

Anteil an der Berechnung der Modulnote: 100%

weitere Erläuterungen:

Assessment and examinations: Portfolio: PL: Oral examination (45 min, 3 examiners); LAB (SL, AP)

Calculation of the grade for the module: 100% from oral examination

Erstablesung: WS 2018/2019, 1. Wdh.: SS 2019

1. Prüfer: Andreas Hirsch

1. Prüfer: Dirk Guldi

1. Prüfer: Franziska Gröhn

1. Prüfer: Rainer Fink

1. Prüfer: Julien Bachmann

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### **Organisatorisches:**

**Frequency of offer:** Annually/start of studies is available in summer and winter term Courses "I" in winter term, courses "II" in summer term

**A5:** LAB Course upon individual appointments with respective contact persons

**B1 - B3:** winter term

**B4-B7:** summer term

**Bemerkungen:**

**Courses of study for which the module is acceptable:** M.Sc. Molecular Nanoscience