Modulbezeichnung:	**Schwerpunktfach Advanced Processes (AP focal)** (Focal subject Advanced Processes)	**15.0 ECTS**
Modulverantwortliche/r:	Robin N. Klupp Taylor	
Lehrende:	Marco Haumann, Marcus Halik, Matthias Thommes, Leonid Datsevich, Hans-Joachim Egelhaaf, Malte Kaspereit, Hannsjörg Freund, Andreas Bück	

Startsemester: SS 2019	Dauer: 2 Semester	Turnus: halbjährlich (WS+SS)
Präsenzzeit: 150 Std.	Eigenstudium: 300 Std.	Sprache: Englisch

Lehrveranstaltungen:

In the third MAP semester (WS),the lecture "Catalysis" is obligatory.
In addition, one of the following two lectures with the respective exercises has to be chosen:
Adsorption: Fundamentals and Application
or
Drying Technology

Thin films: processing, characterization and functionalities. (SS 2019, Vorlesung, 1 SWS, Hans-Joachim Egelhaaf)
Reactors (SS 2019, Vorlesung, 1 SWS, Leonid Datsevich)
Process Technologies (SS 2019, Vorlesung, 2 SWS, Hannsjörg Freund et al.)
Process Technologies Exercises (SS 2019, Übung, 1 SWS, Markus Kaiser et al.)
Catalysis (WS 2019/2020, Vorlesung, 2 SWS, Marco Haumann)
Adsorption: Fundamentals and Applications (WS 2019/2020, optional, Vorlesung, 2 SWS, Matthias Thommes)
Trocknungstechnik/Drying Technology (WS 2019/2020, optional, Vorlesung, Andreas Bück)

Empfohlene Voraussetzungen:

basics in physical chemistry

Inhalt:

Reactors:

- chemical reactor and catalyst as a result of interdisciplinary knowledge and efforts
- industrial catalysis
- types of chemical reactions
- types of chemical reactors
- mass and heat balances for ideal reactors operating under steady-state and unsteady-state conditions
- divergence of a real reactor from an ideal one
- safety aspects
- multiphase catalysis: problems and solutions
- examples of industrial development: three-phase reactors

Process Technologies:

The course "Process Technologies" gives an overview on important processes in the chemical process industries. The processes are treated in a holistic approach and the interaction of individual process steps and their feedback to the overall process are discussed in more detail. In particular, the relationship between the physical/chemical basics of the processes, process development and process design will be discussed. The presented processes are selected based on their importance in the fields of raw materials, intermediates and consumer products of the chemical process industries. In the sense of process engineering, apart from the reaction steps, the separation operations are also part of the considerations. The evaluation of the methods with regard to their cost-effectiveness and sustainability complete the description of the processes. In detail, the following aspects will be treated:

- Raw materials (crude oil, fuels, natural gas, technical gases)
- Organic base chemicals (syngas, alkanes, alkenes, aromatics)
- Organic intermediates (C1-C4 alcohols, cyclic alcohols, ether, epoxides, organic acids)
- Renewable raw materials
- Organic end products (surfactants, pigments, polymers)

- Inorganic base chemicals and intermediates (sulfuric acid, ammonia, sodium hydroxide)
- Inorganic end products (fertilizers, ceramics, glass)
- Process development (technologies, economic evaluation)

Thin films:

- overview on passive materials in organic electronics (substrates, dielectrics, packaging and encapsulation materials)
- dielectric properties, barrier properties, optical properties
- major thin film fabrication processes (gas phase and solution based)
- printing (gravure, ink-jet, doctor blading) techniques and conditions
- composition of inks, thin film homogeneity and thickness control
- deposition of patterned features
- molecular self-assembly (molecular scale fabrication, applications).

The Catalysis lecture covers

- Homogeneous catalysis
- Fluid/fluid biphasic catalysis
- Hatta number and enhancement
- Advanced solvents for catalyst immobilization
- Heterogeneous catalysis
- Deriving reaction rate approaches for surface catalyzed reactions
- Reactors to determine kinetics of reaction and mass transfer
- Mass transfer coefficient correlations
- Mass transfer influences on selectivity
- Mass transfer in fluidized beds
- Models to describe residence time distributions
- Catalyst characterization
- Chemical energy storage

Adsorption: Fundamentals and Applications
1. Introduction and terminology
2. Gas adsorptions basics and adsorbent materials 3. Physisorption mechanisms
4. Surface area determination
5. Porosity and pore structure analysis of nanoporous materials 5.1 Micropore analysis
5.2 Mesopore analysis
5.3 Macropore analysis : adsorption and liquid intrusion methods
5.4. Characterization of hierarchically structured porous materials
6. High pressure adsorption 7. Surface chemistry effects on adsorption
8. Adsorption and characterization in the liquid phase 8. Adsorption of mixtures 9. Adsorption applications in gas storage and separation

Lernziele und Kompetenzen:

Students who successfully participate in this module can
define different types of chemical reaction and reactor
differentiate between steady-state and transient reactor operation
evaluate the differences between idea and real reactors
assess aspects of safety of chemical reactors
define challenges and solutions for multiphase reactors
describe the importance of thin film technologies to modern (opto)electronic devices
define principal gas and solution-based thin film fabrication technologies, especially printing techniques
evaluate the composition of printing inks and characteristics and quality of printed layers
explain how thin films can be patterned
understand the role of emerging thin film technologies such as molecular self-assembly
Students who successfully participate in this module can
explain the material, technological and developmental aspects of chemical processes
understand the fundamentals of both homogeneous and heterogeneous catalysis

analyze and evaluate the general mechanisms in catalysis
describe and critically asses the interplay between mass transport and chemical reaction
apply immobilization techniques for homogeneous catalysts
transfer their knowledge about chemical reactors regarding influences on catalytic processes

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