## Elective Lecture

| Module number | Credits | Workload | Term | Frequency | Duration |
|---|---|---|---|---|---|
| | 5 CP | 150 h | 1. Sem. | only WS | 1 Semester |

| Courses | Contact hours | Self-Study | Group size |
|---|---|---|---|
| Heterogeneous Catalysis | a) 2 SWS<br>b) 1 SWS | 105 h | All students choosing Industrial Chemistry |

**Prerequisites**

Solid knowledge of basics in Industrial Chemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry

**Learning outcomes**

- Students get insight into the scientific basis of heterogeneous catalysis, with emphasis on the elementary steps of catalytic reactions, on relations between catalyst structure and reactive properties, between preparation routes and obtained structures, and on the interdisciplinary approaches in catalyst research. They are introduced to the most important characterization methods for heterogeneous catalysts and get an overview over the most important technical applications of heterogeneous catalysis. The course enables students to orient themselves in the multifaceted field of industrial heterogeneous catalysis and creates the basis for own scientific activities in catalysis research.
- Soft skills: interactive presentation in front of an audience, notetaking during lectures, unsolicited post-preparation of module contents, unsolicited consultation of the relevant literature

**Content**

1. Elementary steps of heterogeneous catalysis - chemisorption: energetics, adsorption sites and surface phases; surface reaction, surface reaction dynamics
2. Relations between structure and reactivity of catalytic surfaces - spatial structure: anisotropy of surface structures and properties in metal and non-metal catalysts, ensemble effects and their use, electronic structure - volcano relations and their basis, ligand effects
3. Promotors and poisons in catalysis - chemical and structure promoters and mechanisms of their function, promoting selectivity and stability, basics of poisoning effects
4. Supported catalysts - introduction to texture properties, structure and properties of important supports, surface chemistry of typical supports, interactions between supported components and supports
5. Preparation and activation of catalysts - basis steps in the preparation of solid materials from the viewpoint of catalysis, addition of active components to supports, shaping of catalyst pellets, thermal aftertreatment, activation of catalyst precursors
6. Important catalyst types and their application - metal catalysts (including bifunctional catalysis), catalysis with redox oxides, industrial acid catalysis, environmental catalysis
7. Characterization of heterogeneous catalysts - laboratory reactors for reactivity characterization, texture characterization by physisorption and chemisorption techniques, thermoanalytical (temperature-programmed) methods, structural analysis by XRD, by X-ray absorption, surface analysis by XPS, ISS, vibrational spectroscopy, optical and scanning probe microscopy, miscellaneous techniques (incl. Mößbauer-, EPR-, NMR- and UV-vis spectroscopy)

**Teaching methods**

a) Lecture; b) Exercises

**Mode of assessment**

30 min end-of-term oral exam

**Requirement for the award of credit points**

Passing the oral exam

**Module applicability**

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| Master of Chemistry, focal point Industrial Chemistry |
| **Weight of the mark for the final score**<br>Weighted according to CPs |
| **Module coordinator and lecturer(s)**<br>B. Mei, M. Muhler |
| **Further information**<br>All lectures, additional contents of exercises, summaries of student lectures are distributed via *moodle*. |