

## Custom-made catalysts

# Development, deposition, and testing of catalysts

The development and testing of catalysts is a fundamental key element of the technology chain covered by the division Energy at Fraunhofer IMM. Besides custom-made catalysts, the development work of the division comprises system design, process simulation, reactor design, development of cost-effective manufacturing technologies, system control, system integration, and system testing.

### Customized catalyst development

You can benefit from our expertise in developing new catalysts and the deposition of catalysts. Both, catalysts and catalytic coatings, are tailor-made for the reactors and processes envisaged. Our core competencies are the development of new catalysts, the optimization of existing catalyst formulations with respect to selectivity and activity and the improvement of the robustness of catalysts under real process conditions. In addition, you can also benefit from our existing portfolio of long-term stable catalyst formulations for various heterogeneously catalyzed gas-phase reactions.

#### Current focus of catalyst development

To date, the development of catalysts have been mainly focused on:

- reforming of carbon-based fuels for hydrogen production
- utilisation of ammonia as hydrogen carrier

- utilisation of carbon dioxide e.g. for methanol and methane production
- syngas formation
- fuel synthesis
- VOC and exhaust gas treatment

#### Catalyst preparation and handling of catalyst powders

Amongst others, the standard repertoire of preparation methods includes batch-wise precipitation, precipitation under continuous flow conditions, wet impregnation, and combustion synthesis and other preparation procedures.

With respect to the investigation of catalysts in fixed-bed reactors, also procedures for pelletizing, crushing and separation of different size fractions by sieving are available.

#### Deposition of catalysts by surface coating

For deposition, the catalyst powders are suspended in appropriate solvent/binder systems. The resulting suspensions are then filled into the channels of monolithic catalyst carriers or structured substrates. After a final drying and calcination step, the catalyst remains as a thin layer (10-30  $\mu\text{m}$ ) on the surface of the microchannels. For catalyst screening or small reactor prototypes, the filling step is carried out by hand. For a larger quantity of plates and production purposes, a unique deposition procedure using screen-printing is available.

## Catalyst testing

### Reactors

The testing of catalysts is offered as a service. Catalysts can be investigated as powders having a well-defined particle size distribution in fixed bed reactors made of quartz or stainless steel.

Alternatively, catalysts can be investigated as thin layers on structured substrates made of steel, alloys, aluminum or other materials for example specific metals such as titanium. For test purposes, small chip-type reactors are applied. Such reactors can be loaded with a catalyst amount in the range of 10-300 mg or more.

### Test facilities

At present, twelve test rigs are available for catalyst testing. The configuration of these test rigs allow the investigation of various reactions such as reforming, ammonia decomposition, combustion, water gas shift, preferential oxidation, methanation, and methanol synthesis. Additionally, existing test rigs can be adapted or new test rigs can be equipped according to the specifications of your application.

The rigs are configured in such way that they can be operated 24/7 to allow short-term as well as long-term experiments. The latter take typically 1000 h and can be prolonged according to your requirements.

### Experimental conditions

- temperatures up to 1000 °C
- pressures up to 120 bar
- flow rates of up to 20 L/min in the test rigs for catalyst testing and up to 1 m<sup>3</sup>/min in the technical center
- evaporator for water and liquid fuels

Adaptations towards higher temperatures and pressures or other requirements can be carried out according to the specifications defined by our clients.

### Analytical instruments

All test rigs are equipped with appropriate analytical equipment such as

- microGC
- process GC
- FTIR
- GC-MS
- online MS

These allow the online determination of all relevant gaseous reactants and products.

## Services and benefits

### Our services in the field of catalysis

- development of new and optimization of existing catalytic formulations for your process
- characterization of catalytic materials with regard to specific surface properties
- evaluation of catalytic performance under process-related conditions
- upscaling of procedures for catalyst preparation
- development of procedures for the handling of catalyst powders
- deposition of catalysts onto structured substrates

### Your benefits

We offer you a one-stop service including the entire technology chain starting with process simulation, catalyst development, and reactor development and culminating in the construction and testing of fully automated plants for the generation of power or the production of chemicals.

With regard to the catalytic materials, you can benefit from our existing portfolio of long-term stable catalyst formulations or you can take advantage from our existing knowledge in the fields of catalyst preparation, catalyst testing, and catalyst deposition.



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