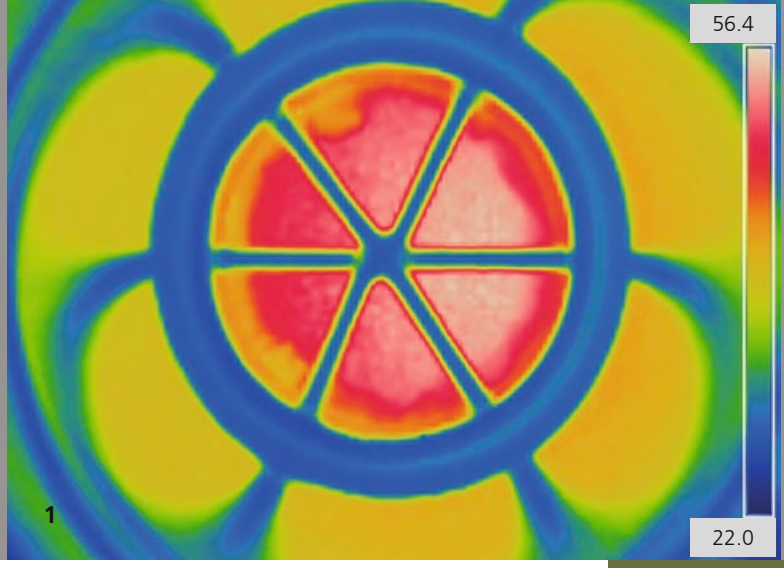

HIGHLY DYNAMIC MICROWAVE HEATING OF REACTORS

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Thanks to their high geometric surface area and outstanding flow properties, structured catalysts offer several benefits for application in heterogeneously catalyzed reactions. The best-known example is the use of ceramic honeycomb catalysts for emission reduction in exhaust gases from engines and stationary sources. In contrast to honeycombs, open-celled foams have a network-like structure. This allows for additional radial mass and heat transport within the reactor.

Although catalyzed reactions require less activation energy, many catalytic processes still require increased temperatures in order to achieve adequate conversion rates. Accordingly, an optimized thermal reactor management is the prerequisite for efficient reaction control. Conventional methods of heating and cooling are typically based on the traditional techniques of heat transfer through convection, heat conduction and radiation. However, these processes are usually slow and thus difficult to control. Compared with this, the advantages of microwave heating consist in contactless and volumetric heat transfer as well as quick controllability of the heating process. This offers the possibility to respond much more efficiently than with conventional heating methods to discontinuous exhaust gas quantities, application-related fluctuations in the exhaust gas temperature, and dynamic reactions.

In cooperation with the Fraunhofer Institute for Chemical Technology ICT, Fraunhofer IKTS has investigated direct microwave reactor heating using specifically modified cellular catalyst carriers, tested in different applications of gas phase chemistry. Based on these results, a scalable system for microwave-heated reactors was developed. A homogeneous and deep penetration of the microwave energy is the prerequisite for the rapid and uniform heating of the reactor. In addition, a sufficient entry of the volumetric power dissipation is essential for using the catalyst structure as microwave susceptor.

Structured catalysts, which are able to meet the demands on microwave transparency and absorption of microwave energy, were developed by tuning the dielectric properties of silicon-carbide-based open-celled foams. For this purpose, both the cell structure and the material composition of the catalysts were modified. Validation tests of the reactor system demonstrated the specific advantages of the dynamic heating method in catalytic gas phase reactions, such as CO and HC oxidation and SCR-DeNOx reaction. Thanks to the very rapid heating rates, conversions greater than 90 % could be achieved for both reactions by heating-up the structured catalyst within less than ten seconds to the reaction temperature.

Services offered

- Development and characterization of structured ceramic catalysts with specifically adjusted microwave properties
- Test-bench experiments for the validation of the microwave behavior of catalysts in gas phase reactions

1 Temperature distribution in the microwave reactor (source: Fraunhofer ICT).
2 Tube reactor with open-celled ceramic foam as catalyst.

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