



# Fraunhofer

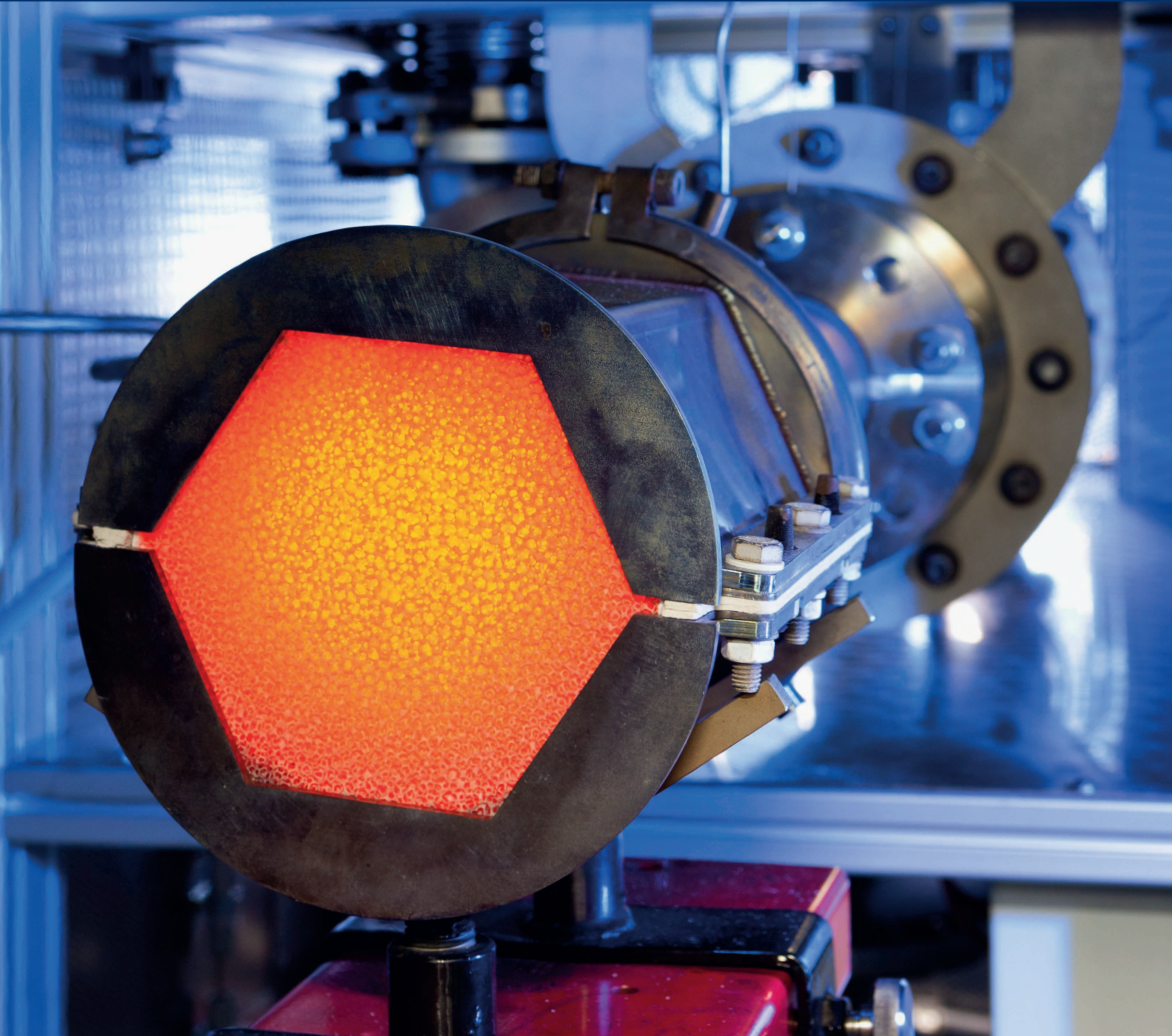
IKTS

FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS



BUSINESS DIVISION

## **MECHANICAL AND AUTOMOTIVE ENGINEERING**





# MECHANICAL AND AUTOMOTIVE ENGINEERING

The “Mechanical and Automotive Engineering” business division at Fraunhofer IKTS traditionally offers wear parts and tools as well as components for extreme conditions made from high-performance ceramics, hard metals, and cermets to be used in machine building, plant engineering and automotive industries. Optical, elastodynamic and magnetic test systems for the monitoring of critical components and production facilities constitute a new area of focus.

The rising costs of energy and raw materials represent in combination with intensified competition in the global markets and increasing demand for sustainability some of the actual challenges for mechanical and systems engineering. Tightened exhaust and fuel efficiency standards have to be met in automotive engineering. By using high-performance ceramic components existing and new systems can be substantially improved.

Fraunhofer IKTS supports its customers with the application-oriented selection and development of materials, while utilizing both established material systems and new combinations. The IKTS team has decades’ worth of experience in designing components that leverage the best qualities of ceramics and hard metals. It is also a veritable font of knowledge regarding the most economically feasible production processes and their successful integration into the user environment. Thus, new application concepts are both swiftly and affordably implemen-

ted in prototype and small-scale series production. When selecting a production process, the team can choose from a broad range of ceramic manufacturing processes that is truly outstanding in terms of its sheer breadth and depth. The existing equipment and installations facilitate the institute’s holistic approach: from upscaling processes on the pilot-plant scale to transferring these processes into industrial production. Test and monitoring systems track the operational status of components and systems. They detect and localize defects early on. A broad and in some aspects unique portfolio of methods for the non-destructive detection of critical material parameters, such as fiber structures and microstructures, mechanical stress, porosity, crack formation and delaminations is available to select the optimum evaluation method. Signals are detected, processed through high-performance hardware components, then visualized and interpreted by the in-house developed software.

## Areas of application

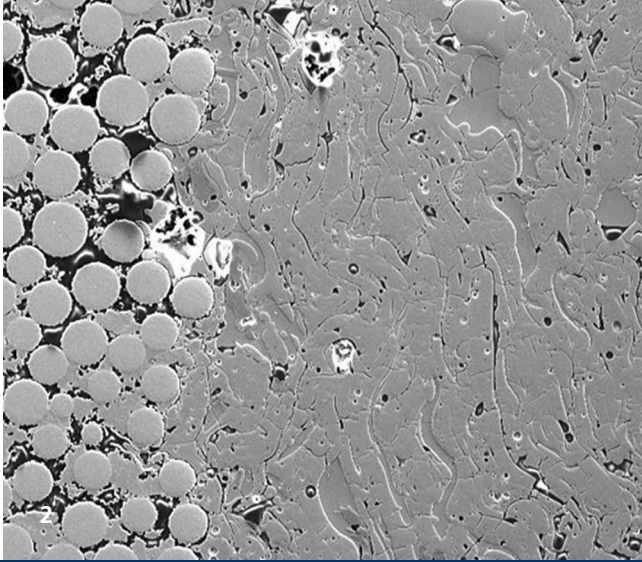
- Wear and corrosion resistance
- Tools
- High-temperature components
- Exhaust gas treatment
- Test systems
- Process, machine and systems monitoring
- Sensor technology

## Expertise

Material and component development

Process monitoring and optimization

Ceramics manufacturing



## AREAS OF APPLICATION

### Wear and corrosion resistance

Due to their remarkable wear resistance in an aqueous or a chemically aggressive environment, ceramic materials are frequently integrated into the core elements of modern technological processes. Thus, they are superbly suited for use in bearings, sealings, valves and pumps. Fraunhofer IKTS is working on new hard and ultra-hard materials, silicon carbide and silicon nitride ceramics, ceramics made of sub- $\mu\text{m}$  corunds, as well as plasma-sprayed, wear-resistant coatings that increase durability and open-up new fields of application.

### Tools

Modern production requires tools that deliver a high degree of process stability. Fraunhofer IKTS develops the commensurate materials and production processes, ranging from hard metals and cermets to super-hard materials and wear-resistant ceramics, as well as thin CVD hard material coatings. Using modern joining techniques, it deploys these materials in reliable and high-performance cutting tools and forming dies. Fraunhofer IKTS assists both manufacturers and consumers in the selection of the cutting materials, as well as their customized production. In addition, the team at Fraunhofer IKTS is developing abrasive grains with ultrafine microstructures and optimized mechanical, thermal and chemical stability to boost grinding performance considerably.

### High-temperature components

High-performance ceramics are especially well suited for high-temperature processes and parts subjected to severe thermo-mechanical loads, since these ceramics almost never change their strength and stiffness under these conditions. By applying monolithic ceramics and fiber composite materials, high-temperature processes can be made more energy-efficient and

sustainable. In addition to materials and processes to manufacture high-temperature components, Fraunhofer IKTS is developing new environmental barrier coatings based on oxide and non-oxide ceramic systems. Other efforts focus on cellular ceramic structures for porous burners and innovative reactors, as well as on electric heaters made of ceramics to attain extremely high power densities.

### Exhaust gas treatment

Ceramics have been used for many years as catalyst carriers and particle filters for treating exhaust gases from mobile and stationary combustion engines fulfilling more and more demanding specifications. Fraunhofer IKTS is developing porous and cellular ceramics as well as catalytic functionalizations for particle filtration (DPT, GPF), DeNOx catalysis (LNT, SCR) and for combined systems (DOC, TWC). The institute offers filter materials with optimized separation and pressure-loss properties, as well as greater ash storage capacity and additional functional components for the exhaust gas system. Naturally, the institute has a rich and broad spectrum of techniques for specific testing and analyses.

### Test systems

Fraunhofer IKTS is the strategic partner for producers of test systems in the areas of mechanical and systems engineering. Beyond numerous standard test procedures, IKTS is certified to offer in-house developed specific test services for characterization, diagnostics and quality assurance. By interlinking electronics with software development, simulation, mechanics and system production, sophisticated test solutions can be delivered both efficiently and on schedule. As a result, customer processes are supported holistically, from development to validation. A traditional focus is on application-specific solutions for material diagnostics by the use of ultrasound, particularly



for railroad engineering. The systems engineered for this purpose are used to inspect high-speed train axles throughout the world.

Fraunhofer IKTS delivers eddy current-based test systems for carbon-fiber composite (CFRP) materials. These test systems make it possible to identify – swiftly, and within the process environment – any defects to the fiber structures inside of CFRP components, both while the CFRP components are in production and when they are in use.

Test and tracking systems based on the use of optical methods play an important role at IKTS as well. Optical coherence tomography facilitates the preparation of high-resolution 3D scans in real time and free of any direct contact with the test samples in order to detect defects, such as air inclusions or impurities. Luminescent ceramic particles virtually pave the way towards entirely new systems of product labeling and batch tracking under extreme process conditions (e.g. high temperatures, excessive humidity, or intensive electromagnetic fields). By changing their optical properties, luminescent materials deliver information on the material conditions within the test specimen and on the process history.

### **Process, machine and system monitoring**

Measurement systems for condition monitoring ensure the reliability and correct functional operation of components and plants, which include for example: drive, valve and joining components, production machines and pipeline systems. Here, Fraunhofer IKTS supports its clients along the entire product lifecycle: from the development, installation and commissioning of systems to permanent operation by continuous system and condition monitoring. The insight into materials and components thus acquired ensures optimal

processes and product qualities, lower production and testing costs, minimizes maintenance time and outages. The methods and measurement systems are configured to withstand harsh service conditions; they process acoustic, optic and electric parameters. Both hardwired and wireless sensor nodes provide information even from inaccessible areas.

### **Sensor technology**

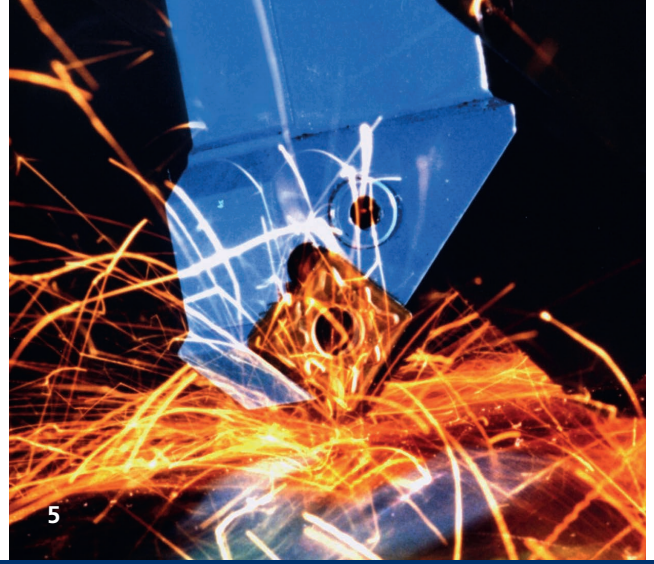
A panoply of new and exciting sensors have been built into modern industrial plants and cars. There, they ensure smooth, reliable and efficient vehicle operation, frequently under extreme conditions. Fraunhofer IKTS has engineered sensors that read pressure, ultrasound, acceleration, power, temperature, soot, flow and chemical composition. Thanks to the keen and in-depth expertise in systems available at the institute, the scientists develop autonomous, miniaturized and wireless sensor systems for machine calibration and for optimization of plant operation. The application of chip solutions and ceramic multilayer technology results in more cost-effective overall production that is calibrated to a higher unit production capacity.

**1** *Injection-molded turbine rotors made of silicon nitride.*

**2** *Plasma-sprayed anti-corrosive coating.*

**3** *Hollow shaft-integrated monitoring system for train axles.*

**4** *Corrosion monitoring system for pipelines.*



## EXPERTISE

### **Materials and component development**

- Application-oriented materials selection and development
- Integrated ceramics design
- Material, component and process simulation
- Material, component and process characterization (aging and wear mechanisms)
- Materials and component testing
- Defect evaluation and failure analysis

### **Ceramic production**

- Sample, prototype, and small-scale serial production under customer-specific aspects
- Proof of readiness for series production
- Upscaling to industrial-scale production

### **Process monitoring and optimization**

- Developing of test and monitoring systems: from sensors to hardware/software, and ultimately to systems
- Defect monitoring of machine parts subject to heavy loads (e.g. cracks, corrosion)
- Autonomous sensor systems for machine calibration and optimization of plant operation
- Product labeling for extreme process conditions
- Wide selection of in-line and non-destructive test methods
- Improved wear behavior and durability

5 *High-precision, ultra-durable tool with integrated ceramic indexable insert.*

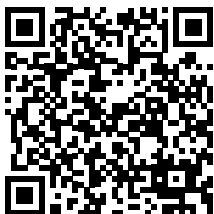
# FRAUNHOFER IKTS IN PROFILE

The Fraunhofer Institute for Ceramic Technologies and Systems IKTS conducts applied research on high-performance ceramics. The institute's three sites in Dresden and Hermsdorf (Thuringia) represent Europe's largest R&D institution dedicated to ceramics.

As a research and technology service provider, Fraunhofer IKTS develops modern ceramic high-performance materials, customized industrial manufacturing processes and creates prototype components and systems in complete production lines from laboratory to pilot-plant scale. Furthermore, the institute has expertise in diagnostics and testing of materials and processes. Test procedures in the fields of acoustics, electromagnetics, optics, microscopy and laser technology contribute substantially to the quality assurance of products and plants.

The institute operates in eight market-oriented business divisions to demonstrate and qualify ceramic technologies and components as well as non-destructive test methods for new industries, product concepts and markets beyond the established fields of application. Industries addressed include ceramic materials and processes, mechanical and automotive engineering, electronics and microsystems, energy, environmental and process engineering, bio- and medical technology, optics as well as materials and process analysis.

[www.ikts.fraunhofer.de](http://www.ikts.fraunhofer.de)



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**COVER** Ceramic catalyst  
carrier subjected to cyclic hot  
gas testing.