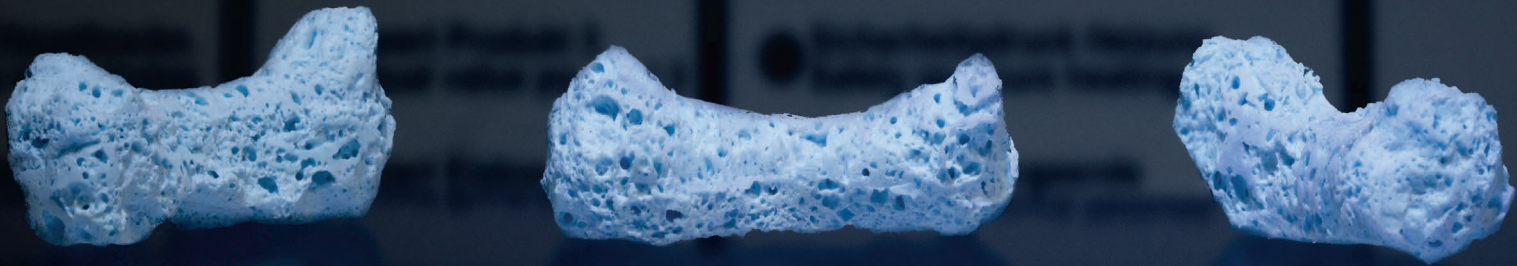




BUSINESS DIVISION

**BIO- AND
MEDICAL TECHNOLOGY**





BIO- AND MEDICAL TECHNOLOGY

Through its “Bio- and Medical Technology” business division, Fraunhofer IKTS offers ceramic materials, components, and systems for dental technology and endoprosthetics, as well as biomedical diagnostics and therapeutics.

The vast wealth of experience with ceramic materials forms the cornerstone by which Fraunhofer IKTS is able to support industrial and research partners with product development, from raw materials to complete medical devices and equipment. Quality assurance, cost control and enforcement of regulatory requirements: these three pillars are a central part of the medical technology efforts at Fraunhofer IKTS and are guaranteed by its superior technical infrastructure, including certified laboratories. There are longstanding collaborative relationships for the processing of customer-specific tasks as well as in the framework of validation and certification processes.

Fraunhofer IKTS is certified under the German Medical Devices Act for its research and development efforts in the field of bioceramic materials and components, and the production of semi-finished products for use in medical technology. These materials are mainly used in dental technology and endoprosthetics, specifically as bone replacement materials, and in the design of bioceramic surfaces and ceramic bodies. With commercially available materials as a basis, IKTS scientists develop new ceramic materials and components with improved and modified properties that accommodate the needs of a gradually and steadily aging population. In doing so, the scientists use the latest foaming, molding, and slip casting technologies, apply plasma coating and sol-gel processes, as well as innovative approaches, such as additive manufacturing.

Processes used in cell and tissue diagnostics – which provide insights into the behavior of cells within the body and against foreign substances – represent another focus at Fraunhofer IKTS, and thus contribute to the diagnosis and the treatment of serious diseases. The institute’s extensive portfolio of physical characterization processes form the basis of these efforts. They are enhanced by its vast expertise in imaging methods, as well as the processing of large volumes of data. The focus here is on the processes, systems and instruments integral to stimulation and monitoring of cells and tissues, and for separating, detecting, and suppressing microbial organisms and toxins. These optical, acoustic and bioelectrical processes are also qualified for use in clinical laboratory diagnostics, point-of-care diagnostics, and home-care applications. The spectrum of services covers everything from design, process, and software development, to construction and assembly of prototypes, to assistance with transferring these to the production phase.

In addition to biophysical, biochemical and biomechanical test laboratories, Fraunhofer IKTS also possesses the adequately equipped, certified laboratories for cell and immune biology as well as for the analysis of environmental and health risks by nanoparticles. It is in this manner that targeted solutions to overcome challenges in medical technology as well as the life sciences and home-care segments can be developed and transferred into applications.



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AREAS OF APPLICATION

Implants

For many years, bioceramic materials have been created and optimized at Fraunhofer IKTS, together with functional components for implantology. With the aid of foaming and casting technologies as well as plasma coatings and sol-gel processes, Fraunhofer IKTS is able to produce and functionalize dense and cellular bioceramics. Novel approaches – such as additive manufacturing or functionalization by means of sensor and actuator systems – are new core research topics for the next generation of implants.

Dental ceramics

To ensure that dental ceramic components have the right appeal regarding their aesthetic traits, biocompatibility and extraordinary durability, Fraunhofer IKTS researches new types of materials, components and production technologies. The institute is able to process oxide-ceramic materials – e.g. to dental restorations – through continuous process chains (CAD/CAM). In addition, it is possible to targetedly structure the surface of oxide ceramic based implants through the shaping process. For the dental ceramics field, the institute developed a lithium silicate for thin-layer veneering of monolithic restorations made from yttrium-stabilized zirconium oxide. This product delivers a superior adhesive bond, is easy to apply and renders

post-implant follow-up superfluous. The comprehensive set of characterization methods facilitates a steady improvement of the properties at the material/semi-finished product level. As part of its initial preparatory research, it studies the most modern processes – such as additive manufacturing of dental components – optimizes these and certifies them for use in serial production.

Biosensors and bioactuators

Knowledge of how biological tissues interact with various materials is decisive for the development of implants and biofunctional microsystems. The combination of bioceramic materials and biophysical systems creates synergies between ceramics and microsystem technology, thus permitting the production of diagnostic and therapeutic medical devices.

Fraunhofer IKTS has unique expertise in the development of monitoring systems that are used in studies of cellular and microbial growth processes. In addition, Fraunhofer IKTS is working on biophysical actuator systems to promote the targeted growth of tissues on implant surfaces and inhibit bacterial growth. New kinds of transmission systems ensure that implants have wireless and battery-free power supply.

Areas of application

Implants | Dental ceramics | Biosensors and bioactuators | Surgical instruments and components | Analytics and diagnostics

Expertise

Biomaterials

Sensor and actuator systems

Characterization methods

Substrate

Monitoring systems

Surface

Testing and diagnostic processes

Coating



Surgical instruments and components

Ceramic materials are distinctive for their wear resistance, biocompatibility, and chemical inertness, as well as for their targeted modulation of electrical conductivity. This enables creative approaches to the manufacture of functionalized surgical instruments as well as a wide diversity of components used in medical technology. High-precision ceramic cutting materials and instruments that clamp and obliterate within one work step, or ceramic springs for X-ray devices: the point where other materials reach the end of their potential is precisely where ceramic materials just begin to exhibit their myriad advantages. With this in mind, the team at Fraunhofer IKTS is constantly in search of trendsetting applications for use in the components and devices of medical technology, to bring the benefits of ceramics to the human race.

Analytics and diagnostics

Innovative procedures in optical, acoustic, and bioelectric analytics open up new pathways for the next generation of medical diagnostic systems. At center stage in the research conducted by Fraunhofer IKTS are the methods, components, consumable materials and complete systems for oncology, biomedicine, and clinical applications.

Optical methods represent a unique focal point because they can perform rapid, ultrasensitive and contact-free measurements. It is therefore the ideal tool for measuring biological processes and defects at the cellular level. This means that the institute can already respond to many medical and diagnostic issues confronting the field of medical technology and the disciplines of life sciences in a simple, cost-effective manner.

The IKTS, in joint collaboration with the Fraunhofer Institute for Cell Therapy and Immunology IZI, established the

Bio-Nanotechnology Applications Lab (BNAL) for this purpose. At the interface between cellular biology, medicine, biotechnology, nanotechnology, and medical technology, scientists address issues affecting everyone, from biological/medical basic research or process engineering to validation and certification of the latest technologies and system solutions.

- 1 *Zirconium oxide for dental applications.*
- 2 *Additive-produced lower jawbones.*
- 3 *Electrochemical multisensor array made of LTCC.*
- 4 *In-vitro cell monitoring.*



EXPERTISE

Ceramic materials and surfaces

- High-purity dense or porous bioceramics (Al_2O_3 , ZrO_2 (ATZ, ZTA, Y-TZP), $\text{Ca}_3(\text{PO}_4)_2$ and HAP)
- Open-cell ceramic foams and metal foams
- Glass and glass ceramics ($\text{Li}_2\text{Si}_2\text{O}_7$)
- Oxide and non-oxide ceramics with targeted electrical, thermal, mechanical, and optical functionalities
- Composites (polymer ceramics) and material composites (porous/dense, metal/ceramic)

Technologies

- Powder and slurry preparation
- Casting, pressing and plastic shaping processes
- Foaming and replication technologies for cellular structures
- CAD/CAM line
- Oxide ceramic semi-finished products (EN ISO 13485:2012-certified)
- Plasma coating and sol-gel processes
- Additive manufacturing
- Thick-film and multilayer technology (complete line for HTCC, LTCC)
- Thin-film technology (thermal CVD, PECVD, thermal ALD, PVD, LPD)
- Microprocessing and surface processing
- Biocompatible packaging and joining techniques
- Design and construction of medical devices
- Upscaling and technology transfer

Diagnostic and treatment systems, characterization

- Bioelectrical, topography-based, acoustic and optical measurement systems
- Biophysical characterization at the nano, micro and macro levels (TEM, SEM, AFM, AFAM, Raman)
- In-vivo and in-vitro analysis and diagnostic systems (fluorescence-based tumor diagnostics, theranostics)
- Sensor and actuator systems for the study of stimulation and suppression processes
- Plasmonic sensor systems
- Power transmission and communications systems
- Laboratory diagnostics in S2 environment

5 3D visualization of a tooth, using optical coherence tomography.

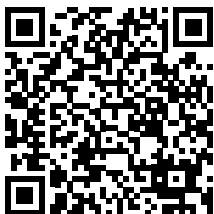
FRAUNHOFER IKTS IN PROFILE

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.

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COVER *Freeze foamed
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