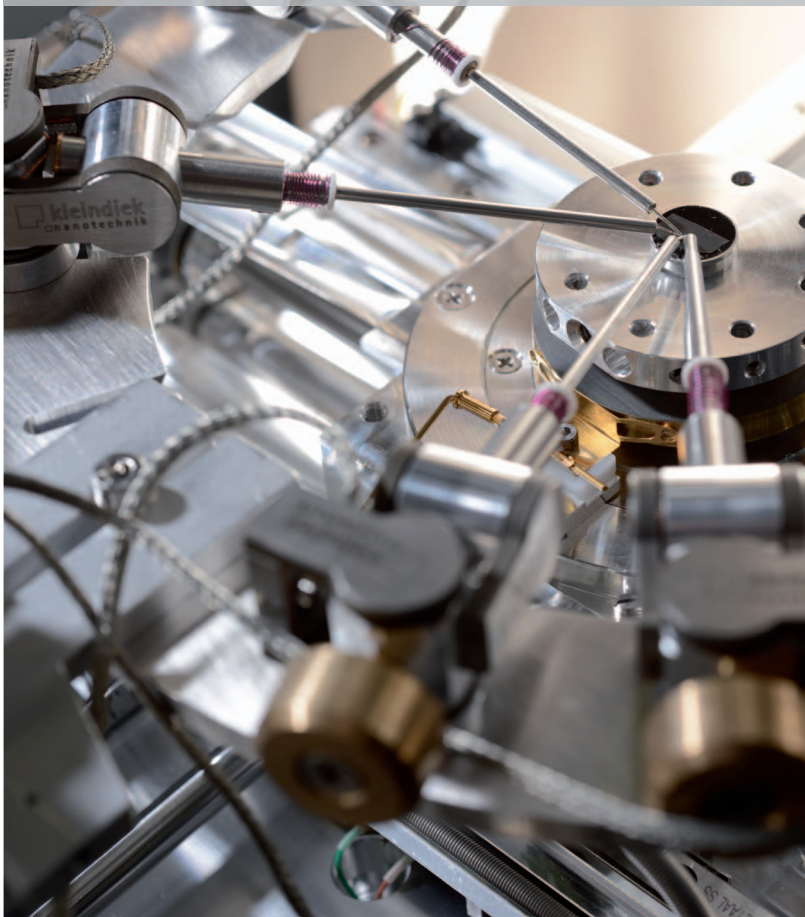
Fraunhofer ISC

FRAUNHOFER INSTITUTE FOR SILICATE RESEARCH ISC

CENTER FOR APPLIED ANALYTICS



Do you have a tangible problem with one of your materials or products?
Do you wish to better understand your materials, to compare or evaluate them under special aspects?
Do any of the properties of your materials bother or puzzle you?

Do not hesitate to contact us!

Our analysis experts will find a solution.

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THE CENTER OF APPLIED ANALYTCS ZAA – PARTNER OF INDUSTRY AND SME

Comprehensive and application-oriented material analyses

Material analyses are indispensable for efficient material research and development. As part of the Fraunhofer Institute for Silicate Research ISC with its focus on materials R&D, the Center of Applied Analytics ZAA offers an extensive portfolio of advanced materials analysis techniques for both in-house and external customers.

Our expertise lies in the characterization of materials, coatings and surfaces as well as in trace element and damage analysis. Thus, a correlation can be made between a material´s structure and its behavior.

Specific questions regarding, e. g. glass, ceramics, metals, hybrid polymers or construction materials, can be given comprehensive and solution-oriented answers placed into an overall context.

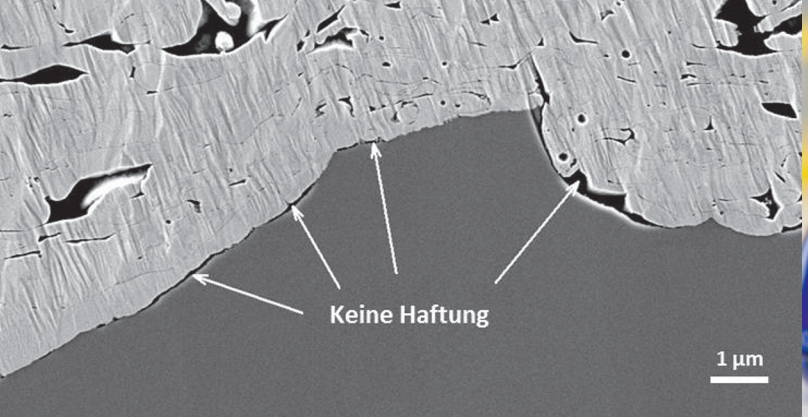
The Center for Applied Analytics ZAA is accredited to DIN EN ISO/EC 17025 and RAL and also as EUCEB testing laboratory for mineral wool.

Perfectly equipped to meet R&D requirements, we also offer our partners from industry and economy the optimization of production processes and concomitant quality assurance.

Competence on demand for small and medium-sized companies

As part of the Fraunhofer-Gesellschaft we lay special emphasis on our responsibility to be a long-term (development) partner for small and medium-sized companies. But we are also perfectly equipped for shorter term R&D or quality control support. Our know-how and expertise is just a phone call away.

This brochure will help you gain an overview of our range of services. For more detailed information, please contact one of our experts.



Damage analysis – application-oriented scientific approach

Material damages can strongly affect production processes and potentially lead to expensive claims for compensation or to product recall. This makes fast reliable support a must.

Years of experience and interdisciplinary competencies within Fraunhofer ISC enable our experts to investigate and analyze damages precisely and efficiently. Along with the analysis results, customers receive a scientific evaluation and overall interpretation. If necessary, solutions will be proposed to optimize materials and/or processes.

Often, related discussions with our clients have even brought up entirely new ideas for novel products.

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Accredited chemical analysis of inorganic materials

Fraunhofer ISC´s accredited chemical analysis laboratories have been offering precise analyses and characterization of inorganic materials for over ten years. Their long-term experience also covers wet-chemical digestion to round-off the range of services.

Available test methods include:

- X-ray fluorescence analysis (XFA)
- Inductively coupled plasma optical emission spectroscopy (ICP-OES)
- Gravimetric determination of silica

Application examples:

RAL / EUCEB mineral wool inspection
hydrolytic stability tests
heavy metal analysis for construction materials
analyses of glass, glass ceramics and ceramics

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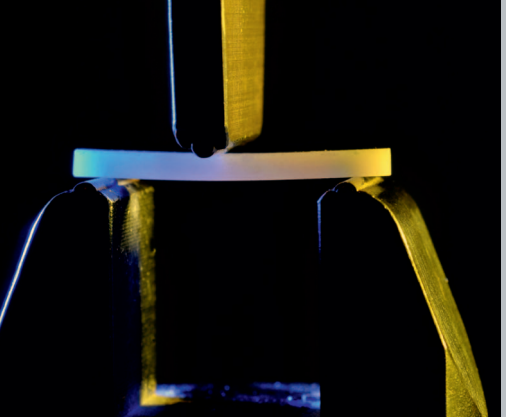
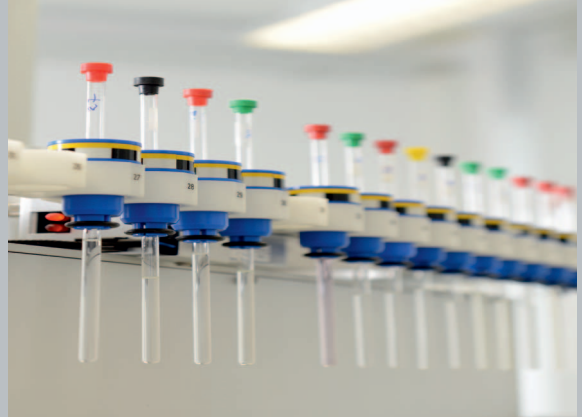
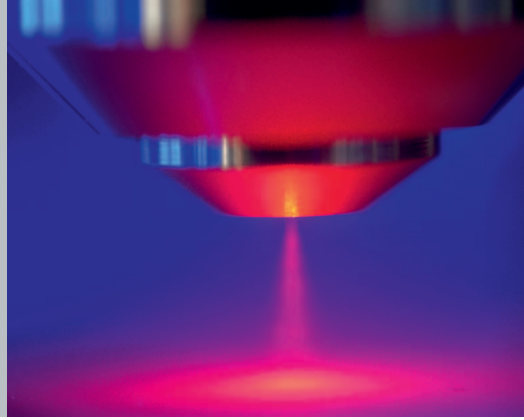

Mechanical testing of materials

The testing of a material's mechanical properties is indispensable to verify product safety or operational capability. Fraunhofer ISC offers a variety of standardized test methods (DIN, ISO, EN) which, on demand, can quickly be adapted to special measurement tasks.

Standard methods include testing of:

- breaking resistance, compressive and (micro)tensile strength
- modulus of elasticity, toughness
- compression/shear and shear strength

Special test methods include

- 2- and 3-body abrasion
- dynamic-mechanical analysis (DMA)
- (micro) hardness

For dental applications, tests include:

- model system for tooth bonding
- in-situ compressive force on dental crowns
- chewing simulation ± thermocycling

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Characterization of (hybrid) polymer materials

Fraunhofer ISC develops hybrid polymer materials for various industrial applications. In addition to the listed methods, the following characterization procedures are also available:

Analytics during the synthesis process:
Spectroscopy: µ-RAMAN, IR, NMR
Chromatography: HPLC, GPC,GC
Titration procedures such as Karl-Fischer or acid titration

Polymerization testing includes the determination of:

- in-situ temperature curve during curing
- Degree of conversion (Photo-DSC, Raman, IR)
- (in-situ) shrinkage

Other procedures:
Determination of viscosity/flow behavior
Color and translucency measurement, UV-VIS
Coefficient of thermal expansion
Investigation of interfaces / roughness

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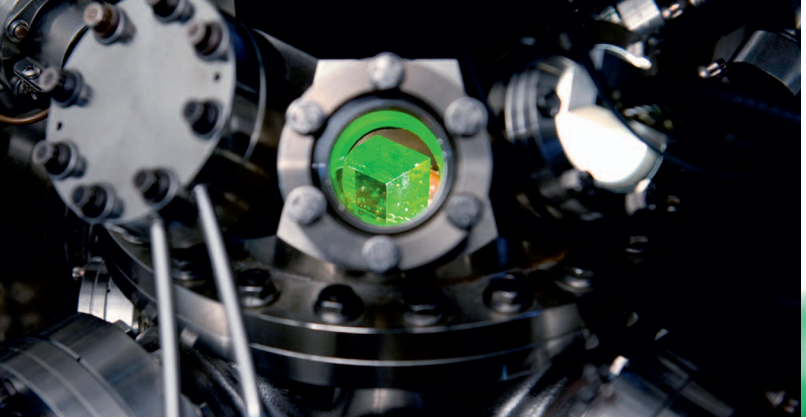

Accredited chemical surface analysis

The surface of a material plays an important role in many applications. A vast number of properties – such as outward appearance, shade, corrosion behavior, electrical conductivity, wetting behavior or adhesion – rely on surface chemistry. Another relevant aspect is cleanliness and its maintenance. Cleanliness is vital when it comes to optical components or to the packaging of medical and pharmaceutical products. An analysis must identify contaminators and their origin.

Fraunhofer ISC offers a wide variety of surface-sensitive meas-urement methods – also for non-conducting material samples:
X-ray photoelectron spectroscopy
RAMAN and (ATR)IR spectroscopy*
ToF-SIMS and SNMS are available at accredited cooperati-on partners

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*nicht akkreditiertes Prüfverfahren

Testing and characterization of surface and coating properties

Surfaces and coatings usually offer a defined function as special feature of a material or a product. The exact character-ization of a property following standardized processes (DIN, ISO, EN, ASTM, SAE) helps to enhance their durabiliby, safety or suitability for daily use.

Test methods includes:

- Determination of resistance to weathering (light and UV resistance, humidity resistance, corrosion resistance, etc.)
- Determination of mechanical surface properties and abrasion resistance with subsequent transmission and light scattering measurement
- Determination of microhardness
- Determination of roughness parameters
- Determination of layer thicknesses
- Determination of wetting angle of contact
- ATR IR spectroscopy
- Micro RAMAN spectroscopy

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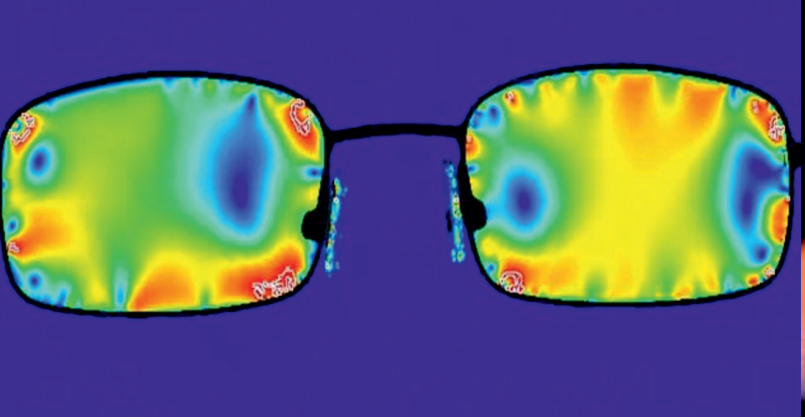

Measuring the physical properties of glass

As one of the oldest glass research institutes in Germany, Fraunhofer ISC does not only offer chemical but also plenty of physical analysis methods to determine the actual properties of glass, glass ceramics, or enamel. For example, a precise knowledge of stress distribution in hardened architectural glass or automotive glazings is essential for a safe and reliable use. And in case of damage, its cause may often be traced back to the distribution of stress.

Test methods include:

- Optical measurement of stress and strain
- Testing of mechanical strength
- Determination of optical properties (transmission, reflect-ion, absorption)
- Determination of thermal properties (thermal expansi-on, glass transition)
- Testing of viscosity
- Testing of dielectric properties
- Glass structure analysis (XPS, NMR and more)

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Accredited laboratory for chemical glass analysis

One of the most vital areas of glass research at Fraunhofer ISC centers around the chemical and structural analysis of glass. Special equipment is available for the wet chemical digestion of glass. Also, we are a competent partner of industry when it comes to damage analysis in glass, whether used in architecture, the automotive sector or in the food and beverages industry. We provide comprehensive analyses, sound evaluations and individual solutions, even on short notice.

Typical analyses include:

- gravimetric determination of silica
- hydrolytic resistance test
- determination of Fe2+/Fe3+ and Cr(VI)
- heavy metals analysis

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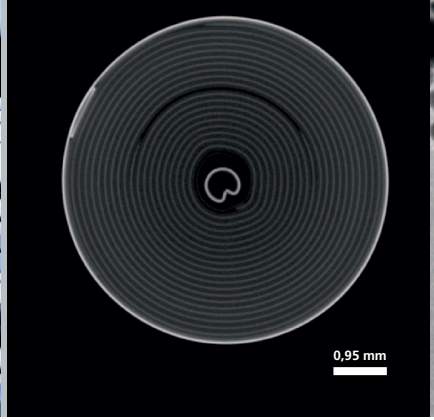

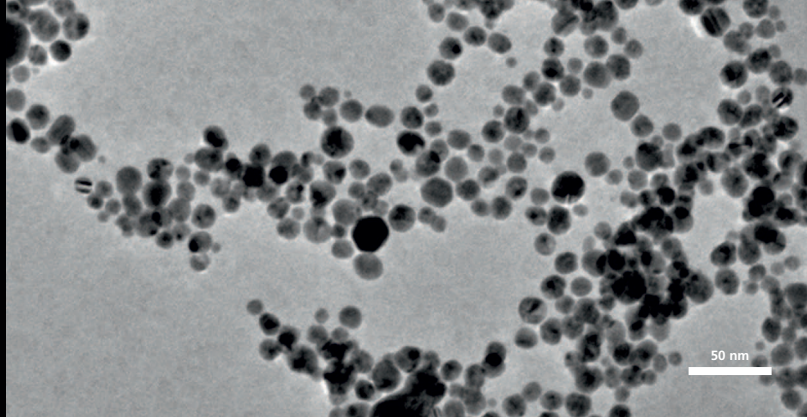

Electrochemical characterization and post mortem analysis

Further progress in electromobility and a better use of renewable energies both rely on advances in the development of high-performance battery storage systems. At Fraunhofer ISC, a vast array of chemical and electrochemical methods is available for a thorough characterization of cells and their individual components.

Available methods include:

- Verification of performance data, quality assurance
- Non-destructive impedance spectroscopy measurement and computer tomography
- Targeted ageing of cells under controlled conditions
- Opening of cells and their characterization in an inert-gas atmosphere
- Micrcoscale measurement of electrical properties (such as interfacial and surface influences between electrode and electrolyte)
- Electron microscopy (HR-REM, TEM)

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Analysis of nanomaterials and nanoparticles

More and more products of our everyday life are based on nanomaterials or include nanoparticles. Special methods are available at Fraunhofer ISC to analyze the structure and chemical composition of such materials. Transmission electron microscopy offers direct imaging and so is the most reliable source for data on a nanometer scale (EU-funded study). This renders it the most important analysis tool.

Other available methods include:

- Dynamic light scattering (DLS) to determine particle size distribution
- BET-N2 sorption measurement to determine (nano) porosity and surface properties
- Photoelectron spectroscopy (XPS and ESCA) to analyze nano layers

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Accredited Electron Microscopy Laboratory

The first essential step in the analysis of materials is the electron microscopic examination. A high-resolution scanning of surface topography and structural features from the micrometer down to the nanometer scale is the key to a throrough understanding of the material's composition. For our expert scientists, a number of different electron microscopes are available as well as an integrated REM microlab workstation which allows microscale measurement of materials properties in situ. Further special emphasis is on the artifact-free sample preparation as prerequisite for an exact analysis.

Electron microscopic equipment includes:

- High-resolution field emission scanning electron microscopy
- Maximum resolution transmission electron microscopy
- Focused ion beam sample preparation under microscope
- Electrical conductivity measurement
- Mechanical pressure testing
- Cryo microscopy

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Thermal analysis

Exact knowledge of a material's thermal behavior is of key importance, and this not only for components obviously destined for higher temperatures but for everyday applications as well. Sunlight alone may cause temperatures to rise up to 120° C. On the other side, temperatures may drop as low as -40° C in wintertime. Extreme temperatures are especially likely to affect composite materials and material combinations when the employed materials exhibit different thermal behavior. This may lead to typical types of damage.

Test methods availabe at Fraunhofer ISC include:

- Thermogravmetric analysis (TGA) using coupled mass and FTIR spectroscopy
- Differential thermal analysis (DTA)
- Dynamic differential caliometry (DDC)
- Dilatometry
- Thermooptical measurements under controlled climate conditions (Climate TOM)

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Analyzing phases

To better understand a material's reaction or all processes involved it may not suffice to know its chemical compostion. The composition of different phases may also play a role. On a macroscopic level it can be determined using X-ray diffractometry (XRD), on a microscopic scale (down to the nanometer range) using the transmission electron microscope (TEM). TEM is often used under cryo conditions.

These methods are suitable to investigate powders, compact samples or coatings. Additional examinations may include XRD measurements in situ under controlled temperature or atmosphere.

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Sample preparation

An artefact-free preparation of samples is vital not only to investigate materials on the micro- oder nanometer scale. In damage analysis, a proper sample preparation may be the key to fast and telling results, even in case of porous or instable material samples.

For this reason, the preparation of samples is a field of its own at Fraunhofer ISC. It specializes in providing cross-sections that are as artefact-free as possible. Techniques include focused ion beam, but also convenstional methods such as grinding, polishing and separation.

New preparation processes are constantly developed to meet up-coming requirements.

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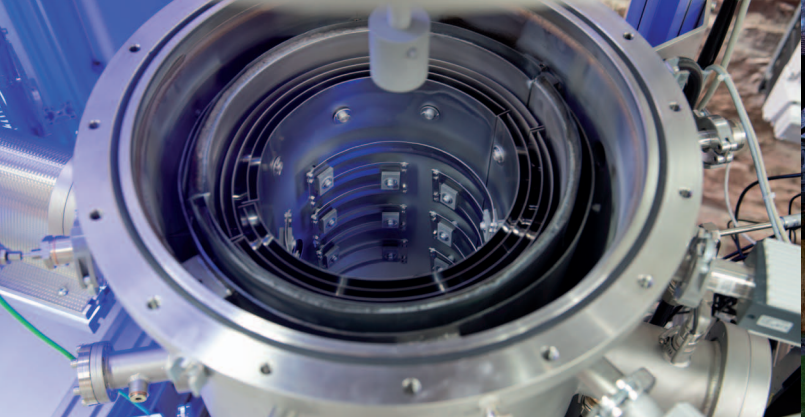

Analysis of environmental influences at the Test Laboratory and Application Center Bronnbach

Materials and products are subject to changing environmental conditions like ambient temperature, humidity, lighting conditions or the concentration of surrounding pollutants. Our KLIMA TOM (TOM = thermooptical measurement device) can measure even the tiniest dimensional effect such changes may have on a material (expansion or shrinkage) with a precision of 0.4 micrometers. This non-contact measurement covers temperatures from -70° C to +180° C and a relative humidity of up to 95%. The test is suitable for all kinds of materials – from construction materials through to electronic components.

The glass dosimetry technique, also developed by Fraunhofer ISC, can register environmental influences, both internal and external. This easy to handle monitoring system measures the effect of pollutants, relative humidity or temperature exposure in indoor rooms, stores or industrial plants.

Other methods include conventional testing such as:

- Climate chambers
- Push rod dilatometer
- Corrosion analysis

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Are your products sustainable and designed for the future?

As manufacturer, do you employ any specific materials? Please note that we offer to team up with your developers and marketing staff for a comprehensive evaluation of the true sustainability of your products.

The Fraunhofer-Gesellschaft promotes and conducts applied research for tomorrow's markets. You can make good use of this well-established and extensive competency network. Why not meet our experts in a joint workshop on the topic of your choice?

We are looking forward to a fruitful exchange.

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