Technische Universität Braunschweig

iBMB MPA TU BRAUNSCHWEIG

Devision of Fire Safety

Fachgebiet Brandschutz

Technische Universität Braunschweig | Institut für Baustoffe, Massivbau und Brandschutz | FG Brandschutz
brandschutz@ibmb.tu-bs.de | Telefon +49 (0) 531-391-5590

Laboratory equipment / as of 2025

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

Center of Fire Research (ZeBra)

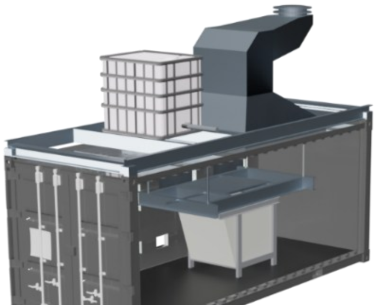
Zentrum für Brandforschung

Technische Universität Braunschweig | Institut für Baustoffe, Massivbau und Brandschutz | FG Brandschutz
brandschutz@ibmb.tu-bs.de | Telefon +49 (0) 531-391-5590

Purpose of ZeBra

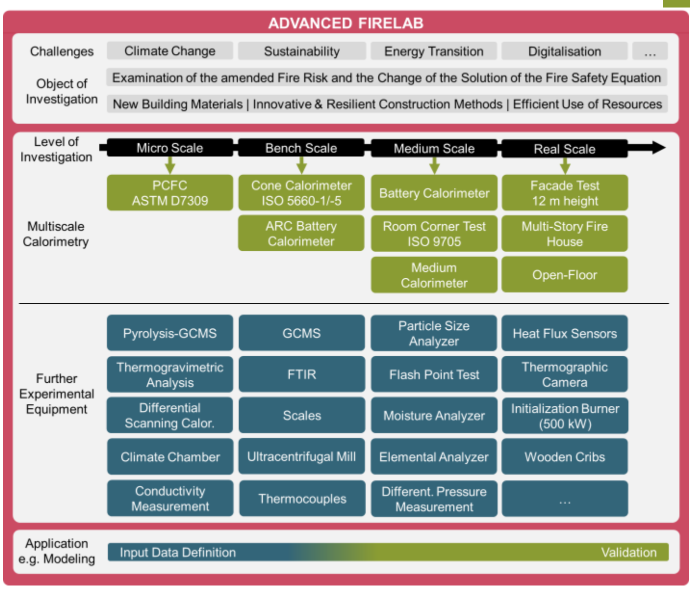
- Fire-safety and resource-efficiency in buildings
- Optimize innovative products in the context of fire safety
- Efficient and robust predictions of the fire development

Real Scale Multi-Purpose Fire House



Medium Scale Battery Calorimeter

Real Scale Open-Floor Calorimeter



Interdisciplinary collaboration

- Fundamental experimental research of fire dynamics and analysis of fire products
- Development of a „new generation“ of prediction models
- **„Advanced Fire Lab“ with different scale calorimeters for heat release rates up to 20 MW as centerpieces** for experimental research as well as calibration and validation of prediction models

Table of Contents:
Equipment ZeBra
Large Calorimeter Investigations

Cone calorimeter K1 (ISO 5660)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The cone calorimeter is used to determine essential fire-specific parameters of solid and liquid materials. Central derived quantities are the heat release rate, the smoke production rate, and the mass loss rate

It is based on the oxygen consumption method that has been in use since 1982. A small sample is exposed to constant radiant heat using a conical heater and ignited by a spark igniter. A coupled Fourier transform infrared spectrometer (FTIR) allows the combustion gases released to be analyzed.

An oxygen reduction chamber is also available as an additional unit.

View of the cone calorimeter

Technical Data

- Sample size: 0.10 x 0.10 x 0.05 m³
- Test duration: generally 30 min
- Horizontal and vertical testing possible
- Power: 5 – approx. 75 kW/m²
- Heat release rate up to max. 10 kW
- Gas components that can be determined by FTIR include: water, carbon monoxide/dioxide, alcohols, carboxylic acids, hydrochloric acid, hydrogen cyanide, hydrofluoric acid, aldehydes, aromatic hydrocarbons
- Determination of:
  heat release rate (HRR),
  total heat release (THR),
  smoke production rate (SPR),
  CO/CO2 release rates
  ignition time (t_ig) and critical heat flux for ignition (q_crit),
  soot particle release, etc.
- Determination of effective combustion heat and combustion efficiency possible (with bomb calorimeter test)

Test in installed condition under radiant heater

Application Examples

- Wall and ceiling cladding
- Materials for automotive engineering
- Materials for rail vehicles
  (in accordance with DIN EN 45545-2)
- Cables and plastics
- Insulation materials and insulation
- Intumescent coatings / insulation layer formers
- Comparative observations of aged/unaged building materials, etc.

Room Corner Test Room K2 (ISO 9705 / DIN EN 14390)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The Room Corner test is a reference method according to ISO 9705 and DIN EN 14390 for investigating the fire behavior of a wide variety of materials, particularly wall and ceiling materials.

For research purposes, the area under the hood can also be used for testing.

Using a coupled FTIR, the released fire gases can be analyzed for their toxicity.

View of the Room Corner test room, consisting of a test chamber, hood, and extraction pipe with measuring equipment

Technical Data

- length x width x height:
  3.600 mm x 2.400 mm x 2.000 mm
- Air exchange via door opening:
  800 mm x 2.000 mm
- Ignition burner 0-300 kW
- Heat Release Rate bis ca. 2.000 kW
- Volume Flows up to 15.000 m³/h
- Determination of:
  Heat release rate (HRR),
  Total heat release (THR),
  Smoke production rate (SPR),
  CO/CO2 release rates
- Determinable gas components of the FTIR include: water, carbon monoxide/dioxide, alcohols, carboxylic acids, hydrochloric acid, hydrogen cyanide, hydrofluoric acid, aldehydes, aromatic hydrocarbons

Experiment under the hood of the Room Corner test

Application Examples

- Wall and ceiling cladding
- Materials for automotive construction
- Materials for rail vehicles (according to DIN EN 45545-2)
- Cables and plastics
- Insulating materials and insulation
- Intumescent coatings/insulating binders
- Comparative analysis of aged/non-aged building materials, etc.

Technische Universität Braunschweig

Façade / Burn House Calorimeter - K3.B / K3.F (DIN 4102-20, 4102-24, BS)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Execution of fire tests with a connected large-scale calorimeter.

Façade Test Stand (K3.F)

Height: 12 m, Corner Configurations up to 3 x 6 m

Testing according to DIN 4102 Part 20 and Part 24

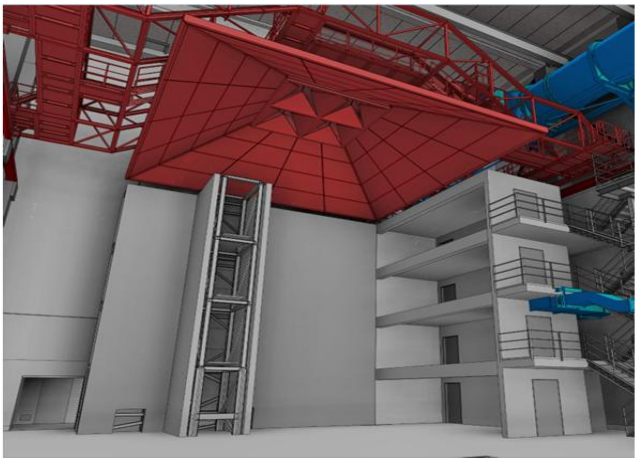
Testing according to British Standard BS 8414-1

Fire Test House (K3.B)

4-story test structure, height: 12 m

Opening widths up to 9 m, internal height 2.7 m

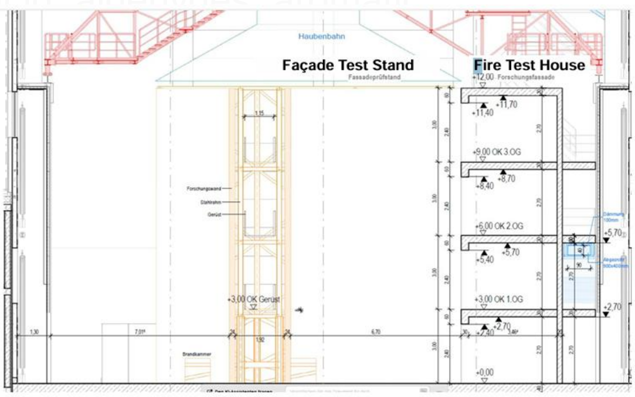
Tests in combination with façade possible



View of the Façade Test Stand and the Fire Test House

Technical Data

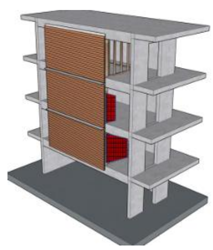
- Hood: 12 x 12 m
- Crane track: 12,5 t
- Height auf hood: 12 m, Edge skirts up to 4 m above ground
- Ignition burner: 0-500 kW
- Heat release rates: up to approx. 20 MW
- Airflow rates: up to 280.000 Bm³/h (operation), 150.000 Nm³/h (standard) achievable
- Individually adjustable air inlet flaps all around
- Multi-Point measurement technology: up to 800 sensors
- Determination of:
  Heat Release Rate (HRR),
  Total Heat Released (THR),
  Smoke Production Rate (SPR),
  CO / CO2 emission rates
- Detectable gas components via FTIR including for example: water, carbon monoxide/dioxide, alcohols, carboxylic acids, hydrochloric acid, hydrogen cyanide, hydrofluoric acid, aldehydes, aromatic hydrocarbons



System Schematic of the Façade Test Stand / Fire Test House

Application Examples

- Façades,
- Room/façade fire scenarios,
- Insulating materials and insulation systems
- Renewable raw materials
- Ventilated façade constructions
- Clarification of issues such as:
  Fire propagation,
  Fire spread, Flash over
  Extinguishing



Open Floor Calorimeter K4 (Open fires, battery fires, warehouse fires, etc.)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Execution of fire tests with connected large-scale calorimeter.

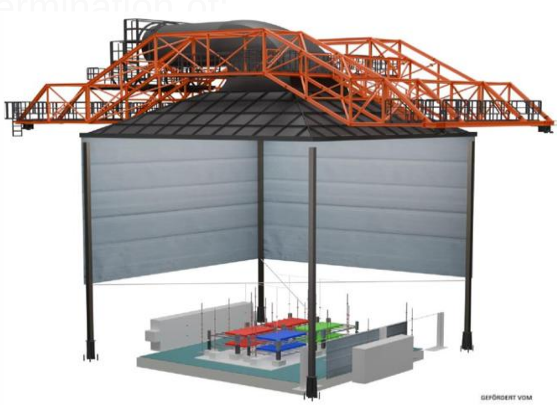
Open Floor Calorimeter (K4)

- Flexible configurations: batteries, storage, setups, carious fire loads
- Individually controllable air supply dampers around the perimeter,
- Edge skirts adjustable to 4 m above ground,
- Support at the corners of the hood usable for vertical measurement levels

View of the Open Calorimeter

Technical Data

- Hood: 12 x 12 m
- Height auf hood: 12 m, Edge skirts up to 4 m above ground
- Crane track: 12,5 to
- Floor scale: 22,5 to
- Ignition burner: 0-500 kW
- Heat release rates: up to approx. 20 MW
- Airflow rates: up to 280.000 Bm³/h (operation), 150.000 Nm³/h (standard) achievable
- Multi-point measuring technology: up to 800 sensors
- Determination of:
  - Heat Release Rate (HRR),
  - Total Heat released(THR),
  - Smoke Production Rate (SPR),
  - CO/CO2 release rates
- Detectable gas components via FTIR including for example: water, carbon monoxide/dioxide, alcohols, carboxylic acids, hydrochloric acid, hydrogen cyanide, hydrofluoric acid, aldehydes, aromatic hydrocarbons



Battery test view in the Open Floor Calorimeter

Application Examples

- Electrical storage systems / batteries,
- Rail vehicles,
- Storage setups,
- Renewable raw materials.
- Clarification of questions on:
  - Fire propagation,
  - Fire spread,
  - Extinguishing

Container-/ Battery Calorimeter K5

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

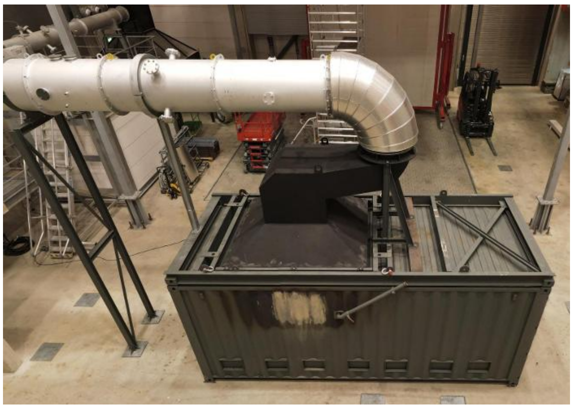
Description

Calorimeter for the investigation of the fire behavior of batteries and ignition sources.

The fire room of the container calorimeter K5 consists of a modified shipping container with an exhaust hood and an optional coolant reservoirs.

Oxygen consumption calorimetry following ISO 9705 and other methods can be applied.

The mass loss and mass loss rate of the test specimen can be measured throughout the fire test. An FTIR system in the exhaust pipe can continuously measure the toxicity of the combustion gases/ products.



View of container calorimeter, with fire room, hood and exhaust pipe with measurement section

Technical Data

- Length x Width x Height (Fire room, standard shipping container): 5.900 mm x 2.400 mm x 2.600 mm
- Gas burner 0-500 kW
- Heat release rate up to ca. 5.000 kW
- (Norm) Exhaust volume rate up 25.000 Nm³/h
- Specimen size restricted up to 800 mm x 800 mm x 500 mm with scale system and otherwise to room volume
- Measurement of:
  Heat release rate (HRR),
  Combustion Heat (THR),
  Smoke production rate (SPR),
  CO/CO2-Release rate,
  Mass loss (ML)-/ Mass loss rate (MLR)
- Identifiable gas components of FTIR: water, CO/ -CO2, hydrochloric acid, alcohols, hydrogen cyanide, hydrofluoric acid, aldehydes, aromatic hydrocarbons
- Use of thermographic camera/ others possible

Fire test in container calorimeter

Application Examples

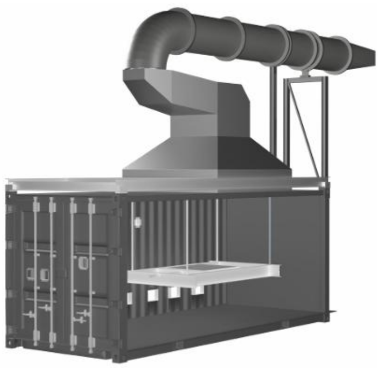


Table of Contents:
Equipment ZeBra
Calorimeter Measurement Technology

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

Mobile Fourier transform infrared spectroscopy gas analyser (FTIR gas analyser)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

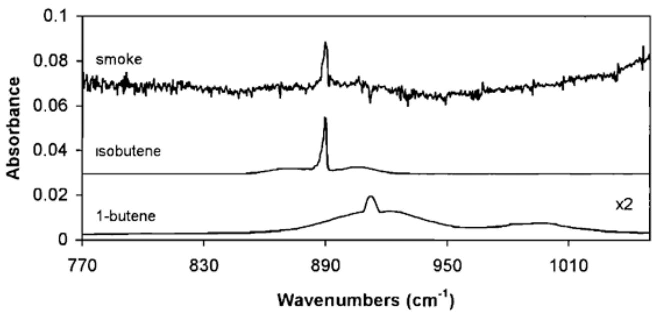
Description

By using Fourier transform infrared spectroscopy (FTIR), both the composition and the concentration of fire gases can be determined. This information provides important insights into the fire process and the resulting consequences. An FTIR gas analyser records an absorption spectrum of the sample gas and can therefore identify molecules based on their characteristic absorption behaviour. Each molecular structure has a unique infrared absorption spectrum. The strength of the absorption is in direct proportion to the concentration, which enables both qualitative and quantitative analyses.

View of the FTIR gas analysis unit

Technical Data

- Sample size: 0.45 l
- Test duration: min. 8 scans, approx. 8 sec.
- Ambient temperature: 5 – 30 °C
- Mirror monolithic and with a gold protective coating
- Optical path length: 5m
- Gas flow: 2-10 l/min (depending on sampling)
- Integrated gas filter to remove particles (2µ)
- Up to 50 infrared-active gases can be determined simultaneously
- Examples of determinable inorganic components: carbon monoxide, carbon dioxide, hydrochloric acid, hydrocyanic acid, hydrogen fluoride, methane, nitrogen oxides, ammonia, sulphur dioxide, water
- Examples of determinable organic components: Formaldehyde, acrolein phosgene, benzene, toluene, o-, m-, p-xylene, ethylbenzene, styrene, phenol, chlorobenzene, ethane, acetylene, ethanol, acetone, ethanoic acid, dinitrogen monoxide, carbonyl sulphide, carbon disulphide



Example for absorption spectrum

Source: https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/1999JD900360

Application Examples

- Qualification and quantification of fire by-products in fire tests
- Toxicity analyses
- Derivation of combustion-chemical reaction mechanisms
- Fire gas analyses

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

Thermography Camera VarioCam HD

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

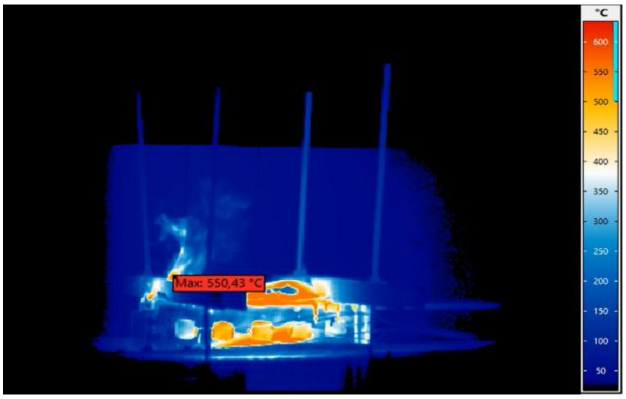
High-resolution thermal imaging head for precise temperature measurement and thermography.

The VarioCAM® HD head is a modular component designed for integration into customized thermal imaging systems. It features a high-performance detector, advanced optics, and real-time image processing. Suitable for industrial inspections, scientific research, and security applications, it provides accurate temperature readings across various surfaces and environments.

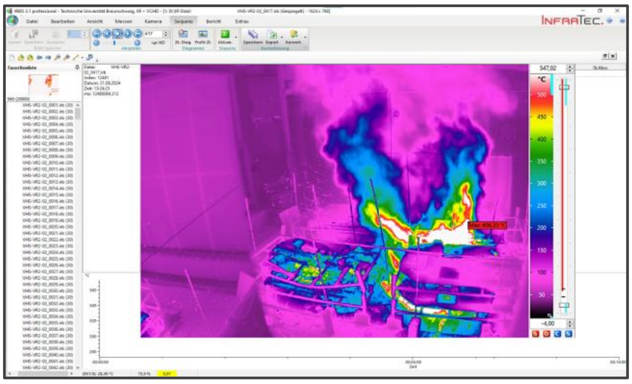
Camera System VarioCAM HD

Technical Data

- Spectral Range: 7.5 – 14 µm
- Temperature Range: -40°C to +1200°C (optional > 2000°C)
- Temperature Resolution: Better than 0.05 K, optional 0.03 K depending on detector type
- Emission Sensitivity: Adjustable from 0.1 to 1.0 in steps of 0.01
- Pixel Format: 1024 x 768, Resolution Enhancement* up to 2048 x 1536 (640 x 480), Resolution Enhancement* up to 1280 x 960
- Measurement Accuracy: ±1.5 K or ±1.5%
- Detector: Uncooled Microbolometer Focal Plane Array
- IR Image Frequency: 30 Hz (1024 x 768), 60 Hz (640 x 480)
- Objectivity (Optics): 1.0/30 mm (32.4 x 24.6°) or 1.0/30 mm (29.2 x 26°)
- Zoom Function: Up to 32x digital
- A/D Conversion: 16 Bit
- Image Storage: GigE Vision 30 Hz or 60 Hz, optional internal SDHC card*



Sample of an infrared image



View of the evaluation software

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

Thermography Camera ImageIR 8300 hp 355

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

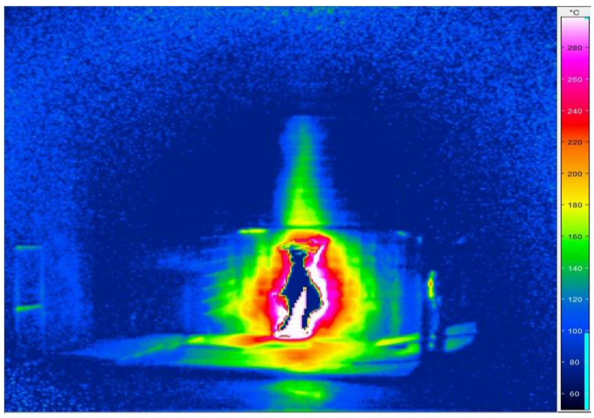
High-performance mid-wave infrared thermography camera for scientific and industrial applications.

The ImageIR® 8300 hp 355 features a cryogenically cooled HgCdTe (MCT) detector with high resolution, enabling precise temperature measurements and detection of subtle thermal phenomena. It covers a spectral range from 3 to 5 micrometers and offers a rapid frame rate of up to 200 Hz for real-time imaging.

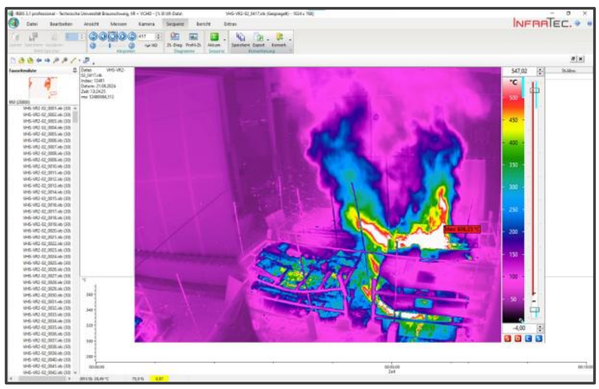
Camera System ImageIR 8300 hp 355

Technical Data

- Resolution: 1024x1024
- Pixel Pitch: 15 µm / 20 µm
- Frame Rate: Up to 200 Hz
- NETD (Sensitivity): < 20 mK
- Spectral Range: 3 – 5 µm
- Dimensions (w/o lens): ~241x120x160 mm / ~235x120x160 mm
- Temperature Range: -40°C to +1500°C
- Lens Types: Wide-angle, Standard, Telephoto, Macro, Micro
- Focal Lengths: 12 mm – 200 mm (main)
- Min. Object Distance: From 14 mm (micro) to 6000 mm (tele)
- Pixel Size (Macro/Micro): From 1.9 µm to 90 µm
- Weight (w/o lens): ~3.3 kg



Sample of an infrared image



View of the evaluation software

Transport and Storage Container Lithium-Ion-Batteries & Accumulators

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Storage container for Lithium-Ion-Batteries/ Lithium-Ion-Accumulators

To conduct small- and large-scale testing with batteries it is necessary to store the test subjects before and after testing.

Because not all batteries have series-production status (either because they were modified before the test or they are critical after the test), they have to be considered as a hazardous material and be stored accordingly.

View of storage container

Technical Data

- Length x Width x Height (Outside):
  2.880 mm x 2.080 mm x 1.045 mm
- Length x Width x Height (Inside):
  2.590 mm x 1.790 mm x 600 mm
- Packing instruction LP 906 (1) for max.:
  144,5 kWh BEV Batteries
  960 kg maximum load
- Requirements from ADR satisfied

Stacked storage containers (empty)

Application Examples

- Storage of battery cells and modules
  Before the test
  Storage of multiple small battery test specimen during longer test series
  Storage of burnt/ tested battery to bridge the time until they are collected for recycling

Table of Contents:
Equipment ZeBra
Laboratory-Investigations

CHNS-O2 Elemental Analysis

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Elemental analysis is used to perform a fast and precise determination of the chemical composition of solid and liquid materials.

In this process, the sample is exposed to high temperatures, undergoing combustion (CHNS analyzer) or pyrolysis (oxygen analyzer).

After separation using a chromatographic method, the released gases or vapors are analyzed. Elemental analysis enables the quantification of carbon, hydrogen, nitrogen, sulfur, and oxygen.

Evaluation of a standard sample (reference: Elementar)

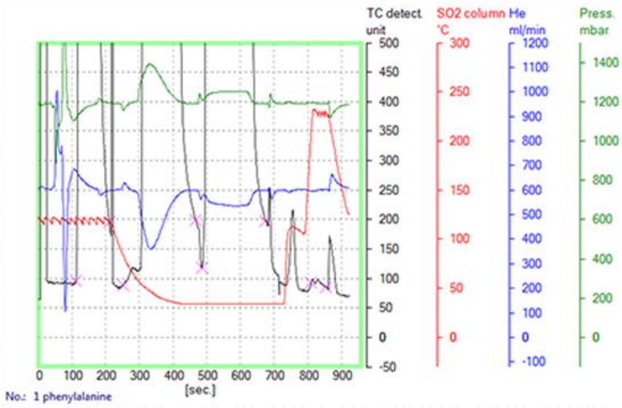
Technical Data

Sauerstoffanalysator O2

- Analysis time: approx. 14 minutes
- Device dimensions: 48 cm x 55 cm x 63 cm
- Maximum temperature: 1450°C
- Sample tray with 120 positions
- Thermal conductivity detector (TCD)
- Carrier Gas: Helium
- Triple furnace system
- Zero-blank ball valve system for sample introduction

CHNS-Makroanalysator

- Analysis time: approx. 3 to 4 minutes per element
- Device dimensions: 48 cm × 55 cm × 57 cm
- Maximum temperature: 1200°C
- Sample tray with 60 positions
- Measurement of carbon, hydrogen, nitrogen, and sulfur in a single run
- Carrier gases: Helium and oxygen
- Triple furnace system
- Zero-blank ball valve system for sample introduction



View of the CHNS analyzer and the oxygen analyzer (O_2)

Application Examples

- Elemental analysis is used to perform a fast and precise determination of the chemical composition of solid and liquid materials.
- In this process, the sample is exposed to high temperatures, undergoing combustion (CHNS analyzer) or pyrolysis (oxygen analyzer).
- After separation using a chromatographic method, the released gases or vapors are analyzed. Elemental analysis enables the quantification of carbon, hydrogen, nitrogen, sulfur, and oxygen.

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

TGA/DSC with FTIR or GC/MS coupling

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

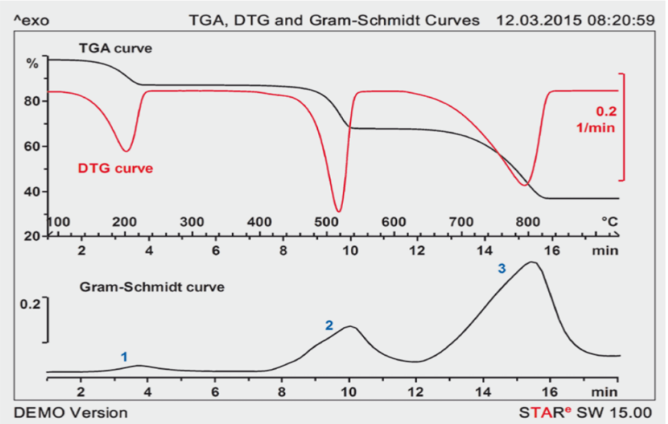
The thermal properties of materials can be investigated using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). TGA measures the mass change of a sample as a function of temperature, while DSC detects changes in heat flow. This allows for the analysis of phenomena such as melting, crystallization, evaporation, and chemical reactions.

Coupling with FTIR enables the simultaneous acquisition of infrared spectra, and the additional integration of GC/MS allows for the separation and identification of volatile organic compounds. Together, these methods offer a comprehensive characterization of material samples.

View of the TGA/DSC- IST16-GCMS coupling

Technical Data

- Analysis of samples from room temperature to 1000 °C
- Simultaneous determination of thermal effects using DSC heat flow measurement
- Gas-tight measuring cell for a defined measuring environment
- High temperature accuracyUp to 34 samples can be processed using different methods
- Crucibles with volumes from 20 to 900 µL and different materials
- Crucibles with volumes from 20 to 900 µL and various materials



TGA-FTIR Result (Source: Mettler Toledo)

Application Examples

- Investigation of the fire behaviour of materials at different temperatures
- Emission analysis to understand the hazard potential of fires and take appropriate protective measures
- Development of fire protection materials Identification of fire accelerants and fire risks
- Analysis of fire residues to draw conclusions about the cause and development of fires

Pyrolysis Gas Chromatograph-Mass Spectrometer (pyGC-MS)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The pyrolysis gas chromatograph–mass spectrometry (pyGC-MS) system enables highly flexible and efficient automated pyrolysis of solid and liquid samples at temperatures up to 1000 °C, followed by analysis of the thermal decomposition products via GC/MS.

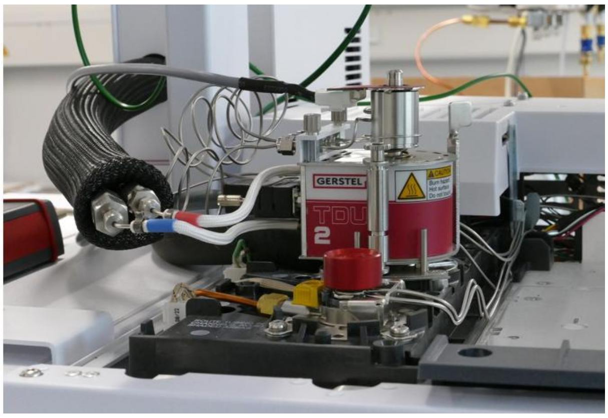
High-molecular-weight organic substances are thermally decomposed into low-molecular-weight compounds under defined conditions before entering the gas chromatographic column.

Small sample volumes and minimal preparation allow for detailed analytical results that are not achievable with other techniques.

View of the pyGC-MS

Technical Data

- Device dimensions: 68 cm × 49 cm × 51 cm
- Multiple pyrolysis techniques available: pulsed, sequential, and fractionated pyrolysis
- Thermal desorption with solvent venting and pyrolysis of the same sample
- Split or splitless operation
- Efficient and reliable automation
- Optimized sample holders for liquid and solid samples
- Maximum heating rate of 120 °C/min
- Flexible modular system
- Automatic liner exchange after a specified number of injections to prevent faulty analysis results due to contamination
- Resistance heating using Pt filament provides selectable pyrolysis temperature from 350 – 1000 °C
- Oven cooling time approx. 4 minutes (from 450°C to 50 °C), 100 K/min



Thermal Desorption Unit With Pyrolyzer

Application Examples

- Characterization of complex material samples
- Toxicity analyses
- Analysis of fire residues
- Identification of fire gases
- Smoke gas analysis
- Analysis of plastics and polymers
- Investigation of fire causes

Technische Universität Braunschweig

ULTRA CENTRIFUGAL ZM 200 (CE)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The ultra centrifugal ZM 200 pulverises a wide range of soft to medium-hard and fibrous substances extremely quickly, thus enabling a high sample throughput.

Soft, elastic products such as plastics, which do not process well at room temperature, can be fed into the ultra centrifugal ZM 200 after embrittlement with liquid nitrogen or dry ice.

Because of its efficient size reduction technique, it ensures the gentle preparation of analytical samples in a very short time.

Ultra centrifugal ZM 200

Technical Data

- Feed material: soft, medium-hard, brittle, fibrous
- Final fineness < 40 µm
- Sample volume:
  - 300 ml with standard cassette
  - 20 ml with mini-cassette
  - 1000 ml with paper filter bag
  - 4500 ml / 2500 ml with cyclone
- Rotor peripheral speed: 31-93 m/s
- 14 different sieve sizes
- Precise preparation of the sample for exact analyses
- Short residence time of the sample in the grinding chamber
- Preservation of the sample's original property characteristics

Ultra centrifugal ZM 200

Application Examples

- construction materials
- Engineering
- Electronics
- Timber
- Metallurgy
- Recycling
- environment

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

CAMSIZER® X2 (ISO 13322-2) PARTICLE ANALYZER

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

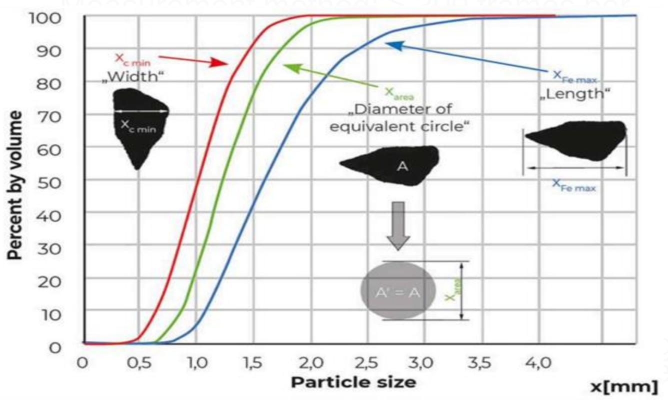
Based on the principle of Dynamic Image Analysis (ISO 13322-2), the CAMSIZER X2 precisely determines the particle size and shape of powders, granules, and suspensions within a measurement range of 0.8 µm to 8 mm. Ultra bright LED strobe light sources and two high resolution digital cameras achieve a capture rate of over 300 frames per second, which powerful software evaluates in real time.

The resulting particle information is ideal for both R&D and routine quality control tasks.

View CAMSIZER X2

Technical Data

- Principle: Dynamic image analysis (ISO 13322-2)
- Measuring range:
  - 0.8 µm to 8 mm
  - 0 µm to 8 mm (free-fall dispersion)
  - 0.8 µm to 5 mm (compressed air dispersion)
  - 0.8 µm to 1 mm (wet dispersion)
- Type of analysis: dry and wet measurement
- Measuring time : 1 to 3 min
- Number of cameras: 2
- Sample quantity: < 20 mg - 500 g
- Measurement method: > 300 frames per second
- Size of the measuring field: 20 x 20 mm
- Resolution: 0.8 µm per pixel
- Measurement parameters: particle size, particle shape & convexity
- Dimensions (W x H x D): 850 x 580 x 570 mm
- Weight (measurement unit): 50 kg
- Evaluation station: Quad Core PC including Windows 10, monitor, keyboard and mouse, network card, PC interface cards for hardware communication, evaluation software



Comparability to Sieve Analysis and Laser Diffraction

Application Examples

- Particle size determination is used in many different industries as part of quality control, e.g.:
- Metal and ore powder
- Cement
- Building materials
- Pharmaceutical powder
- Wood fibers
- Plastic fibers plastic powder

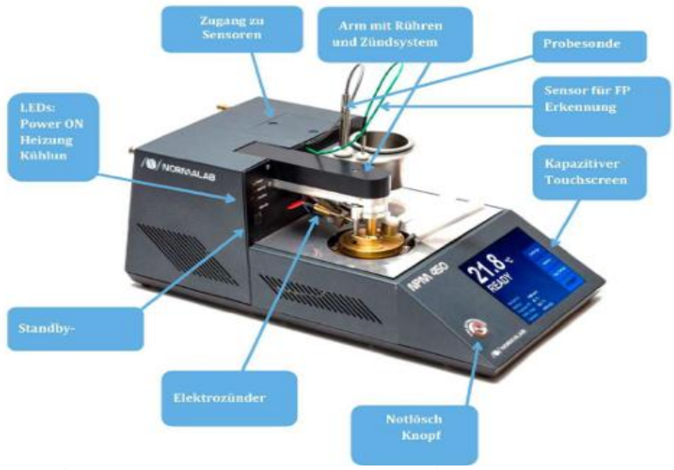
Flammpunktprüfer nach Pensky-Martens
EN ISO 2719

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Verfahren nach Pensky-Martens mit geschlossenem Tiegel (EN ISO 2719:2016)

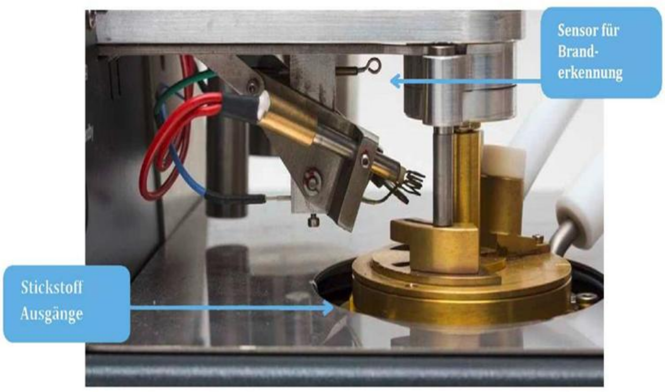
Der Prüfgegenstand wird im geschlossenen Tiegel mit Hilfe eines elektrisch betriebenen Ofens mit Heißluftbad erwärmt und kontinuierlich gerührt. Während man die Temperatur langsam steigert, wird in festgelegten zeitlichen Abständen versucht, mit einer Zündquelle (Flamme), die man durch eine sich öffnende Deckelaussparung einführt, das Dampf/Luft Gemisch zu entzünden. Die Temperatur, ab der eine Entflammung auf der Oberfläche der Flüssigkeit beobachtet wird, wird als Flammpunkt bezeichnet. Die Bestimmung des Flammpunkts nach Pensky-Martens ist in einem Temperaturbereich von 40°C bis 370°C anwendbar.



Flammpunktprüfer

Technical Data

- ASTM D 93 – EN 22719 – IP 34 – ISO 2719
- Thermoelementhalterständer Prüftemperatur Bereich: 0 bis 410°C
- Flammpunkterkennung durch Thermoelement
- Probentemperaturfühler: Typ Platinwiderstand Pt100
- Kombiniertes-Zündsystem (Elektro und Gas)
- Integrierte barometrische Korrektur
- Automatische Wiederzündung der Gasflamme
- Schnelles Aufheizen und Abkühlen
- Heizrate 0 bis 15°C/min
- Sicherheitsstopp 0 bis 30 °C (über Flammpunkt)
- Elektrische Zündung geregelt / überwacht
- Rührgeschwindigkeiten 50 bis 300 U/min (+/-3 U/min)
- Brandmeldesystem mit Ionisationssensorelektrode, die über dem Zündsystem platziert ist, Blitzerkennung



Anschlüsse

Application Examples

- Ein Flammpunktprüfer kann verwendet werden, um die Brandeigenschaften von Materialien besser charakterisieren zu können
- So liegt der Flammpunkt von Teer bei 90 °C, bei Asphalt dagegen bei 205 °C
- Die Unterschiede beim Flammpunkt zwischen festen und flüssigen Materialen sind mitunter sehr hoch
- So liegt der Flammpunkt von z.B. Methanol bei 11 °C und bei Motoröl bei 80 °C
- Es können z.B. Flüssigkeiten die dazu neigen unter den Prüfbedingungen einen

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

iBMB MPA TU BRAUNSCHWEIG

Microscale Combustion Calorimeter (MCC)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

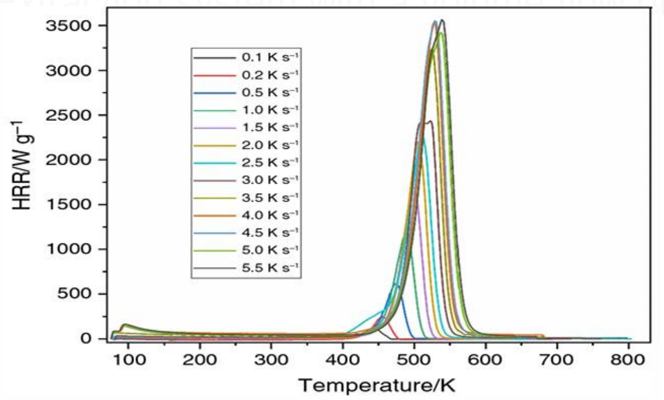
Description

The microcalorimeter is an instrument for precisely measuring the heat energy released during the combustion of small quantities of substances. It is used to analyse the thermal properties of materials, determine the calorific value of fuels and characterise chemical reactions on a microscale. In the process, a sample is first heated and decomposed in the pyrolysis chamber under inert conditions at a constant heating rate. The decomposition products are then fed into a combustion chamber, where oxidation reactions are possible under the influence of oxygen. The energy release is derived via oxygen consumption calorimetry.

View of MCC device

Technical Data

- Sample size: 1 to 5 mg
- Heating rate: 0.4 to 4 °C
- Oven temperature: 25 to 1000 °C
- Repeatability of ± 5 %
- Quantitative results can be generated in just a few minutes
- Extraction system with a volume flow of 100 cm³/min
- Automatic control of temperature and gas flow rates
- Determination of specific heat release rate (W/g), heat of combustion (J/g) and ignition temperature (°C)
- derived via oxygen consumption calorimetry.



Temp. Dependent Spec. Heat Release Rate
https://doi.org/10.1007/s10973-021-10963-4

Application Examples

- Material evaluation
- Development of fire protection products
- Research into the fire behaviour of materials and development of fire protection measures
- Determination of input parameters for numerical fire simulations
- Validation of fire protection standards

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

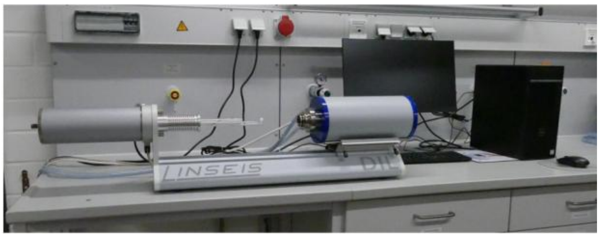
iBMB MPA TU BRAUNSCHWEIG

Dilatometer L76 Horizontal

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The dilatometer is used to determine the thermal expansion, shrinkage and sintering behaviour and dimensional changes of solid, powdered, and paste-like materials. It is based on the push-rod method, which has been widely used in material testing and research. A small sample is subjected to a controlled heating program in a furnace while its dimensional change is continuously measured with high precision. The system allows testing at temperatures up to 1600 °C and operates under various atmospheric conditions, such as inert gas or vacuum, depending on the material requirements.



View of the Dilatometer

Technical Data

- Sample Dia.: 7 mm, 12 mm, 20 mm
- Heating rate: 0.1 to 50 °C/min
- Temperature range: Room Temp - 1600 °C
- Measurement range: 25 – 2500 microns
- Contact force range: 0.02 to 1 N
- Max input power: 3600 W

- Determination of:

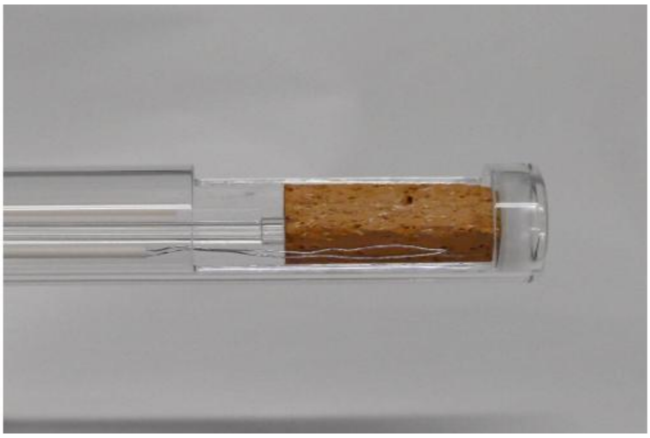
  Change in the absolute sample length,

  Coefficient of thermal expansion,

  Shrinkage,

  Rate controlled sintering etc.

  Thermal length changes for various materials including solids, melt, powders, pastes, ceramics, and fibers



Furnace with a brick specimen

Application Examples

- Materials Science & Engineering: Thermal Expansion Coefficients (CTE)
- Metallurgy & Alloy Development
- Ceramics & Glass Technology
- Polymers & Plastics
- Construction Materials
- Nuclear Materials

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

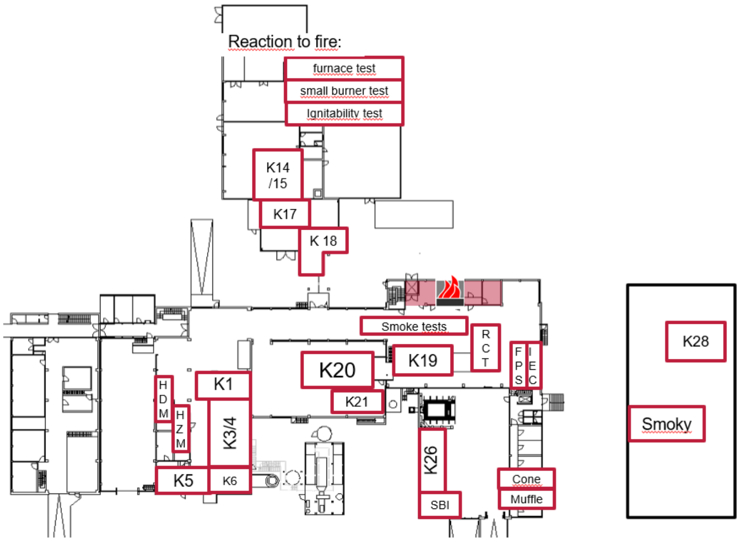
iBMB MPA TU BRAUNSCHWEIG

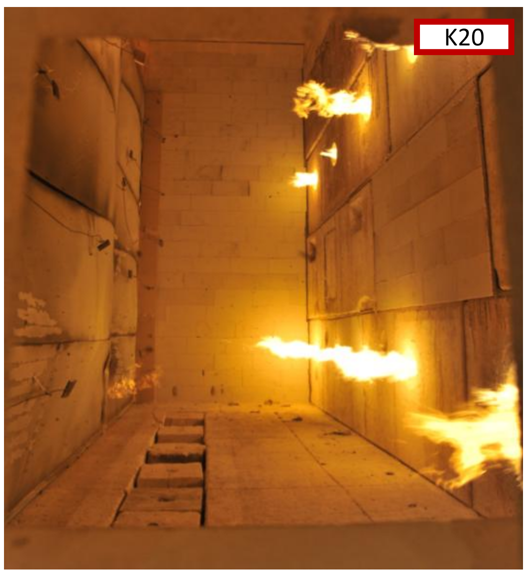
Institute of Building Materials, Concrete Construction and Fire Safety, Department of Fire Safety

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Purpose of the iBMB

- Teaching
  - Fire safety
  - Civil engineering
  - Architecture and environmental engineering
- Research
  - Experimental
  - Numerical
- Knowledge Transfer
  - Braunschweig Fire Symposium
  - Symposium Structural fire engineering
  - Standards (DIN, CEN, ISO)
  - Consulting, surveys





Fire testing facilities for building elements and structures (K1 – K28)

e.g.:

- Wall and fire wall furnace (K5)
- Column test furnace (K19)
- Slab-/ Wall test furnace (K20)

Table of Contents:
Equipment iBMB-fgf
Building Elements and Structures Investigations

Technische Universität Braunschweig

ZeBra ADVANCED FIRELAB

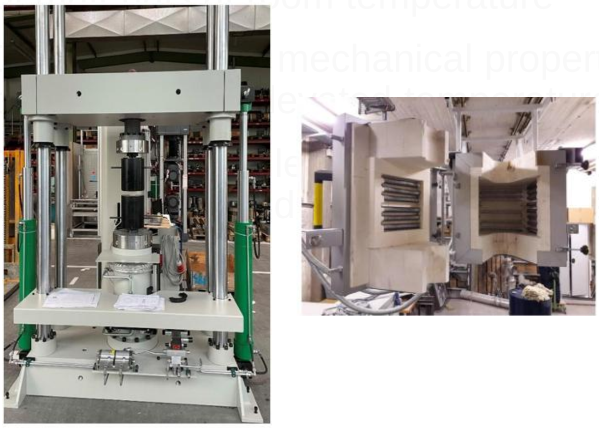
iBMB MPA TU BRAUNSCHWEIG

High temperature tensile testing machine (DIN EN ISO 6892-1, DIN EN ISO 6892-2)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The hot tensile testing system is designed to characterize the mechanical properties of materials under elevated temperature conditions. To facilitate such testing, the existing furnace system is configured to enclose the test specimen during experimentation. The range of experiments includes both steady state and transient hot tensile tests. There is flexibility to adjust various boundary conditions, such as the heating rate. The tests can be conducted under either strain controlled or stress-controlled conditions.

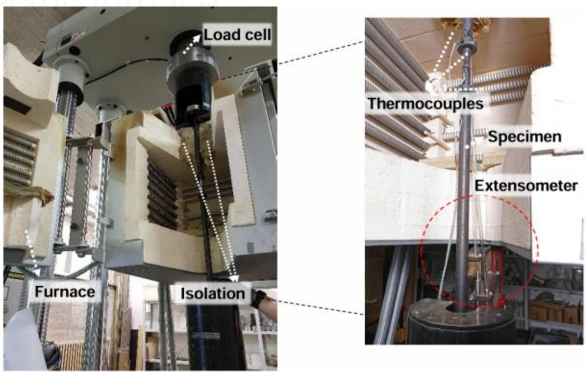


High temperature tensile testing machine

Technical Data

- Load Capacity: up to 1000 kN
- Specimen Types: round and flat specimens
- Testing Capabilities:
  - Vertical tensile testing
  - Strain-controlled and stress-controlled modes
  - Steady-state and transient tensile testing
- Furnace Specifications:
  - Temperature Range: 20°C to 700°C
  - Heating Rate: 2 K/min to 5 K/min

- Determining the mechanical properties of materials at room temperature
- Determining the mechanical properties of materials at elevated temperatures
- Performing tensile tests on different types of steel and specimen shapes



Sample in installed condition

Application Examples

- Tensile tests conducted on materials at elevated temperatures,
- Tensile testing of steel samples
- Development and research
- Materials testing
- Performance of static and quasi-static tensile tests for mechanical characterization
- Execution of test protocols combined with continuous quality monitoring

High temperature compressive stress unit

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

The high temperature compressive stress unit is used to determine mechanical properties of materials in the high temperature range. The unit includes the furnace system integrated around the test sample. The range of tests includes both stationary and transient tests in the high temperature range. The unit offers a flexibility to adjust various conditions, such as the heating rate. Experiments can be conducted using both displacement and force control.

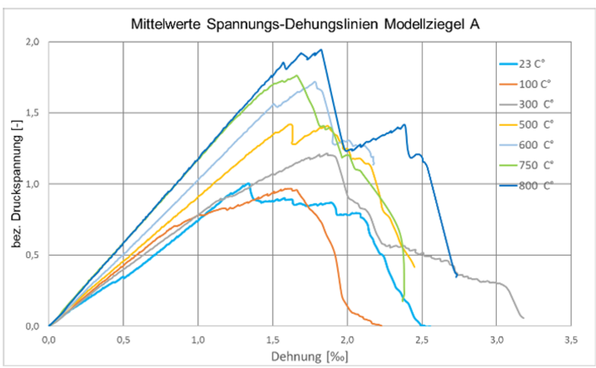
View of the high temperature compressive stress unit and a built-in specimen including temperature- and deformation equipment (bottom right)

Technical Data

- Load unit: max. 4.000 kN
- Specimen height: max. 1000 mm
- Max. temperature: 800 C°
- Electric furnace heating rate: 2 K/min to 5 K/min
- Cooling rate: < 1 K/min
- Cylinder samples with Diameter 80-150 mm / Length 240-300 mm
- Testing options:

  Displacement- and force-controlled vertical pressure testing

  Stationary and transient pressure testing



Stress-strain relations of model bricks determined at different temperatures in stationary tests

Application Examples

- Compressive stress testing of materials at high temperatures by integration of furnace system.
- High temperature compression tests on building material samples: cubes or cylinders made of concrete, ceramics, aerated concrete, sand-lime brick, and brick elements

Fire resistance test furnace-Oskar K19

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

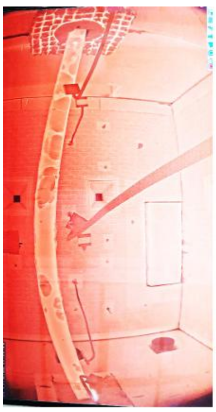
The fire testing furnace "Oskar" is used to determine the fire resistance duration of the structural component, to monitor the temperature development within the element, and to record both horizontal and vertical deformations during exposure to fire. The component is positioned or assembled within the furnace. Mechanical loading is applied to the element via a hydraulic press. The fire scenario is generated by six oil burners installed in the furnace. The behavior of the component during the fire test is documented using a fire chamber camera.

Exterior view of the fire testing furnace „Oskar“

Technical Data

- Furnace base area (test surface):
  3.6 x 3.6 m2 (W x L)
- Test height:
  3.6 up to 5.6 m (H) (modular) max. 7.6 m (without mechanical loading)
- Loading: Vertical, compressive
- Load capacity:
  3300 kN- *100 mm
  4000 kN- *30 mm
  max. 6500kN- *11mm
  *load eccentricity

- Determination of the fire resistance duration of the structural element
- Determination of the temperature development within the structural element
- Determination of the horizontal and vertical deformation of the structural element during fire exposure
- Assessment of the structural behavior under fire conditions



Installed specimen under fire test conditions

Application Examples

- Walls
- Columns
- Gates
- Doors
- Glazing systems
- Fire protection dampers

Ceiling/wall furnace – Loreley (K20)

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

Description

Chamber 20 (Loreley) is the largest fire furnace of the iBMB at TU Braunschweig.

It is possible to investigate fire-exposed building components in real scale with additional mechanical loads during the fire test.

The fire chamber can be used in a wide variety of ways.

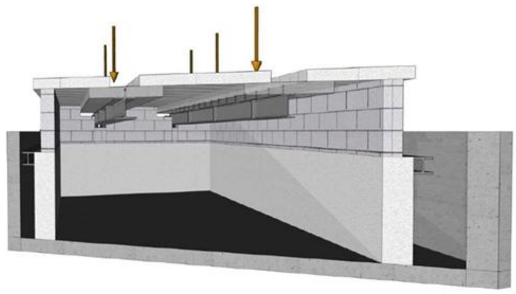
Multiple structures can be installed in parallel.

Chamber 20 is located in a separate hall.

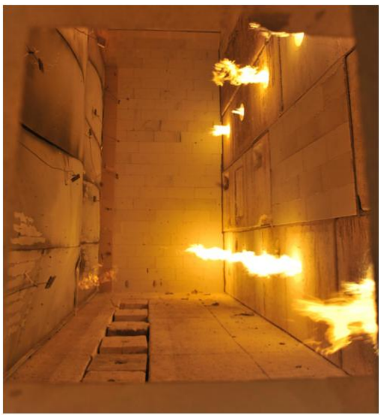
Fire test on mechanically loaded steel beams

Technical Data

- Standard fire tests: DIN EN 13501-2
- Test area (horizontal): approx. 5 x 10 m (W x L)
- Furnace height: > 2.5 m (modularly expandable)
- Can be divided into two separate fire chambers
- Mechanical load (vertical): 6 presses of 300 kN each
- Mechanical load (horizontal): 6 presses of 200 kN each and 3 presses of 1000 kN each
- 10 oil burners



Fire test on mechanically loaded steel beams



Fire test on a mechanically unloaded wall structure made of sandwich panels

Application Examples

- Ceilings and suspended ceilings
- Wall-to-ceiling connections
- Supports
- Rooms
- Glazing
- Cable trays
- Steel segments
- Smoke extraction systems

Technische Universität Braunschweig

iBMB MPA TU BRAUNSCHWEIG

Fire chamber camera

Institute of Building Materials, Concrete Constructions and Fire Safety (iBMB) | Division of Fire Safety
brandschutz@ibmb.tu-bs.de | phone +49 (0) 531-391-5590

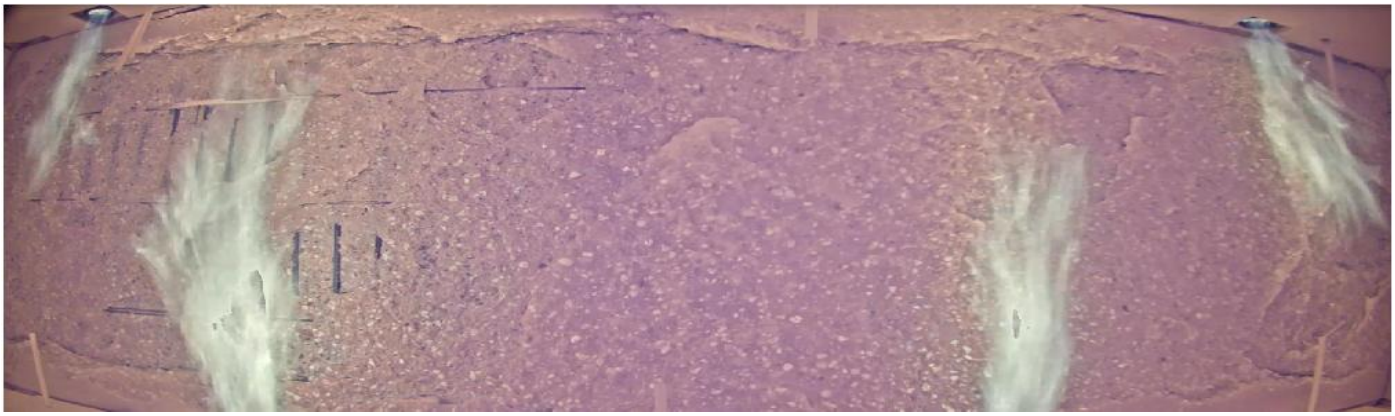
Description

The fire chamber camera (PIEPER Co.) enables live video recording of the component behavior of a test specimen or test setup during a fire test. The camera lens can be aligned axially or radially.

Technical specification

- Max. temperature: up to 1500 °C
- Cooling: Compressed air and water cooled
- Duration of use: at least 48 hours
- Resolution: 768 x 494 pixels

Deformation behavior of a composite column



Investigation of the spalling behavior of concrete