TOM Systems

With specially developed ThermoOptical Measuring systems (TOM), the industrial heat treatment process can be simulated in the laboratory.

- **TOM_ac** for controlled atmospheres, graphite heated up to 2200 °C: Dimensional changes, load tests and gravimetry
- **TOM_air** for operation in air up to 1750 °C: Dimensional changes, load tests, gravimetry and acoustic emission measurement
- **TOM_metal**[1)] for measurement in hydrogen atmosphere or overpressure, graphite heated up to 1800 °C: Dimensional measurements
- **TOM_gas** for measurements in gas burner atmosphere up to 1500 °C: Gravimetry
- **TOM_II** for measurements in gas burner atmosphere up to 1500 °C: Dimensional measurements
- **TOM_wave**[1)] for the measurement of thermomechanical properties up to 1750 °C: Thermal shock, thermal conductivity, modulus of elasticity, emissivity etc.
- **TOM_I** for measurement of the thermal diffusivity of small samples up to 2000 °C: Thermal diffusivity, shrinkage
- **TOM_imp**, for measurements of the electric impedance in air up to 1000 °C
- **TOM_mech**[1)] for measurements of mechanical properties up to 1800 °C: Strength, stiffness, elongation at break, fatigue, creep etc.
- **TOM_fibre**[1)] for measurements of mechanical properties of fibres up to 1500 °C: Strength, stiffness, elongation at break, creep

[1)] Test mode

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Center for High Temperature Materials and Design HTL

High Temperature Characterisation

with ThermoOptical Measuring Systems (TOM)

High Temperature Characterisation

The characteristics of materials change with temperature. They determine the durability of high temperature components and the efficiency of thermal processes. Fraunhofer-Center HTL developed new ThermoOptical Measuring systems (TOM) for the qualification of materials for high operating temperatures and the construction of high temperature processes.

TOM systems determine very different material properties in the temperature range from room temperature up to about 2000 °C:

- Thermal properties
- Mechanical properties
- Thermomechanical properties
- Chemical properties
- Electrical and optical properties

Exact measurements of high temperature properties require a precisely defined local temperature and an atmosphere which is adapted to the sample material, e.g. inert gas atmosphere for oxidation-sensitive samples. In addition, the volume of the sample must be representative for the material. For highly heterogeneous materials (coarse pottery, refractory materials, composite materials) some 10 to 100 cm³ are required. These needs are met by the TOM systems.

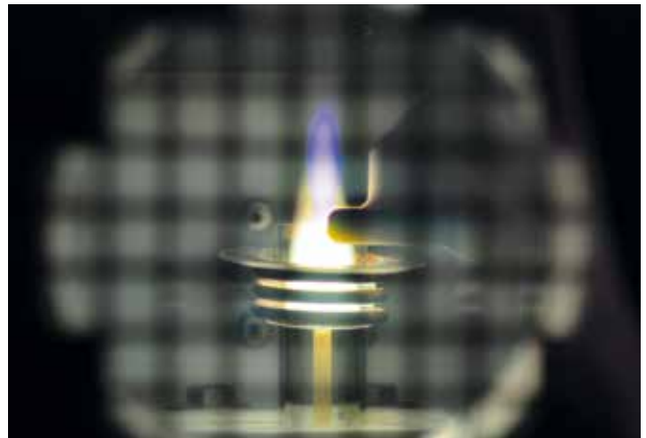
Process Optimisation

At the HTL, various TOM systems are available, which are especially designed for in-situ measurement and optimisation of high temperature processes. The systems are used for the following heat treatment processes:

- Binder burn-out / pyrolysis
- Dehydration
- Sintering
- Melt infiltration

Moreover, the quality of the forming can be checked with using the TOM systems. Using a high-precision shadow imaging technique, the dimensional changes of the samples can be measured during the heat treatment. In addition, changes in weight can be measured. Microphones register the acoustic emission in the case of formation of cracks in the sample. By applying uniaxial load with special push rods, creep can be examined. Any industrial process atmospheres can be adjusted at the measuring furnaces of the different TOM systems, e. g.:

- Air
- Gas burner atmospheres
- Inert gas
- Hydrogen
- Vacuum to positive pressure (30 bar)



At the HTL, further new TOM systems are developed that can measure material properties in a controlled atmosphere. The following high temperature properties are determined:

- Strength, stiffness and elongation at break
- Vibration resistance
- Softening under load, creep
- Thermal shock and thermocycling resistance
- Dynamic modulus of elasticity
- Thermal diffusivity and conductivity
- Specific heat and thermal expansion
- Wetting behaviour of melts
- Integral and spectral emissivity
- Corrosion resistance against gases and dust particles
- Electrical impedance

For the mechanical tests, load cells with maximum forces between 3 N and 5 kN are used. The fatigue tests are designed for frequencies up to 300 Hz. Thermal shock and thermocycling experiments can be performed with using a well-controlled laser heating. The thermal material properties are measured without contact by a laser flash method specially developed for large samples.