Thermal barrier coatings play an essential role in protecting metallic materials against high temperatures. Fraunhofer ICT has developed a multifunctional coating system based on slurry for high temperatures, consisting of a topcoat made from sintered hollow alumina spheres and a metallic diffusion layer below. The topcoat acts as a thermal barrier and the diffusion layer offers protection against oxidation and corrosion.

**Applications**

- Gas and steam turbines: Oxidation protection and thermal barrier coatings.
- Combustors, steam boilers, etc.
- Fire protection for steels in the construction sector.
- Coatings for high-temperature electrolysis and fuel cells.

**Services**

- Development of multipurpose coatings with thermal barrier and corrosion protection, exploiting the specific properties of metallic micro- and nanoparticles.
- Testing of thermal barrier coatings by applying temperature gradients through heating one side only.
- Testing of materials and components for gas and steam turbines as well as steam electrolysis under pressure and controlled atmosphere (e.g. steam and pure oxygen).
Facilities:

High-temperature ovens
- Pressurized furnace for material tests at temperatures up to 1000 °C and pressures up to 50 bar in oxygen, hydrogen and steam-hydrogen.
- Autoclaves for application-oriented pressure tests, e.g. 850 °C and 30 bar in steam or oxygen, 650 °C at 300 bar in steam.
- Horizontal tubular furnace for temperatures up to 1700 °C.
- Vertical furnace for cyclic oxidation tests up to 1200 °C for samples of max. 12 cm diameter.
- Horizontal tubular furnace for experiments under hydrogen or corrosive atmosphere; temperatures up to 800 °C.
- Muffle furnace for temperatures up to 1100 °C.

Field emission scanning electron microscopy
- Field emission scanning electron microscope Supra 55 VP from Zeiss with variable pressure, equipped with energy dispersive X-ray spectroscopy (EDX) and STEM.
- Field emission scanning electron microscope EVO 60 from Zeiss with variable pressure and EDX.
- Ultramicrotome EM UC6 Leica for sample preparation for STEM.

High-temperature X-ray diffractometry as in-situ analysis method
- The measuring system consists of an X-ray diffractometer with a high-temperature chamber for isothermal measurements and freely-selectable temperature programs up to 1400 °C.
- In-situ identification of corrosion products as a function of temperature and time.
- Simultaneous detection of the thermal expansion coefficients of all phases in the oxide layer and the substrate.
- In situ detection of mechanical stresses in the materials.
- In situ detection of recrystallization effects at high temperatures.
- Spatially-resolved mapping analysis using focusing X-ray optics.

Set-up for spatially-resolved mapping analysis by X-ray diffraction with micro-focus.

2. SEM image of microscale aluminum particles after oxidation.