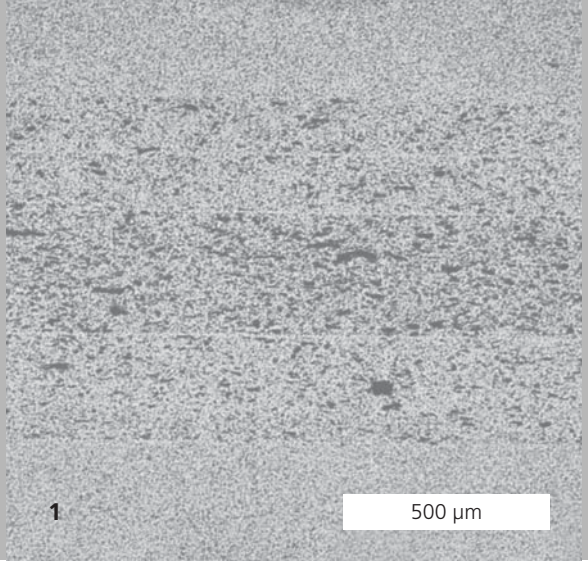

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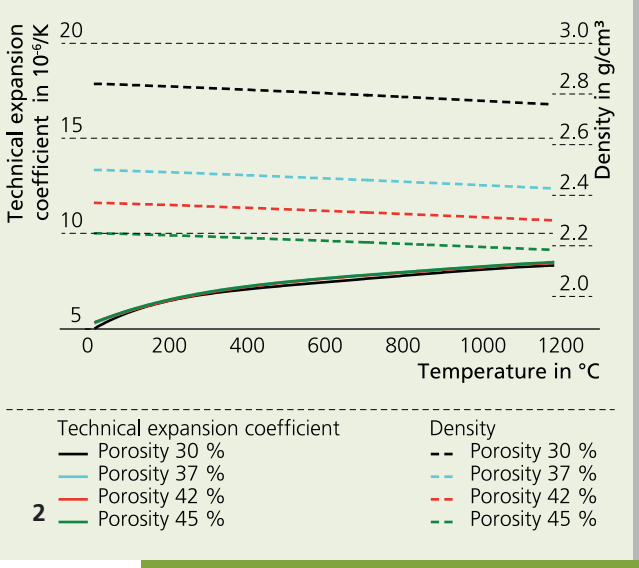

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THERMOPHYSICAL PROPERTIES: BASIS FOR SIMULATION AND FURNACE DESIGN

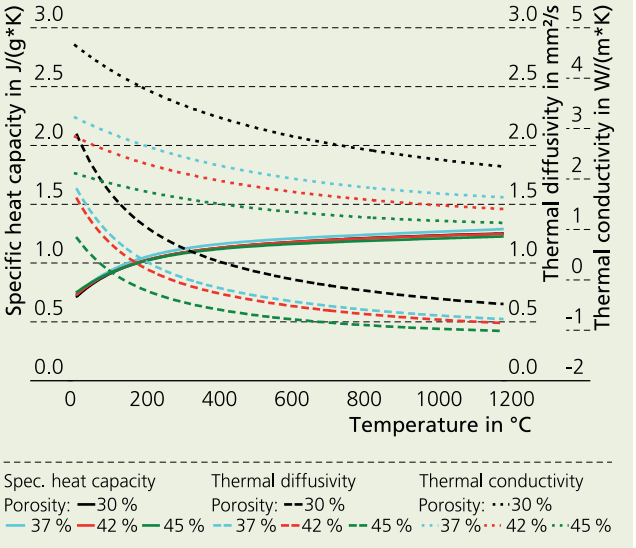
Dr. Tim Gestrich, Dr. Arno Kaiser, Dipl.-Ing. Uwe Scheithauer

Refractories play a key role in all high-temperature applications in different industries, like steel, glass, cement, energy plants etc. At the Fraunhofer IKTS, the principles of manufacturing of refractories with graded properties are investigated. Because of the possibility to adjust properties, the material system Ca-aluminate/alumina is selected. It is produced by a combination of alumina powder and calcium-carbonate in a mass ratio of 11:1. To increase the porosity, cellulose fibers were added in amounts of 0 to 12 wt.-% with regard to the ceramic powder [1]. A microstructure with porosity gradient shall result in improved thermal shock properties of the materials and is realized by the lamination of ceramic green tapes with different contents of pore-forming agents. In order to determine the optimal arrangement of these different tapes by simulation, it is necessary to know the influence of the porosity on the thermophysical properties.

The following methods are used for the determination of the thermal dependence of these properties: Thermal Mechanical Analysis/Thermodilatometry (TMA, TDil) for thermal expansion coefficient $\alpha(T)$ and density $\rho(T)$, Differential Scanning Calorimetry (DSC) for heat capacity $c_p(T)$, and Laser Flash Analysis (LFA) for thermal diffusivity (a). The thermal conductivity $\lambda(T)$ is calculated by means of the following equation:
$\lambda(T)=\rho(T)*c_p(T)*a(T)$.
The measured coefficients of thermal expansion and the heat capacity of the four samples are independent of the porosities and increase with the temperature. Density, thermal diffusivity and thermal conductivity strongly depend on porosity. Higher porosity leads to lower density as well as lower thermal conductivity and thermal diffusivity. The parameters determined are going to optimize this material by simulation for application as refractory material.

The presented results are part of the DFG project SPP1418 "FIRE II". We thank the German Research Foundation for the financial support.

Specific heat capacity, thermal conductivity of multilayered Ca-aluminate/alumina



Services offered

- Determination of thermophysical properties (thermal conductivity, heat capacity, coefficient of thermal expansion)
- Thermodynamic calculations

Sources

[1] Scheithauer, U.; Slawik, T.; Haderk, K.; Moritz, T.; Michaelis, A.: Development of planar and cylindrical refractories with graded microstructure, proceedings of UNITECR 13th, 2013.

1 Cross-section of multilayer components with graded microstructure.
2 Thermal expansion coefficient and density of multi-layered Ca-aluminate/alumina .

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