Thermophysical Properties of Porous Ceramics in relation to the Microstructure:

1) **Relevance to Thermal Insulation,**
2) **Behaviour of Green Bodies during Firing**

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Abstract

Polycrystalline ceramics often contain a pore volume fraction varying from < 1% to > 95%. This talk discusses how the pore phase modulates the thermal properties with a particular focus on the microstructural factors which strongly decrease the thermal conductivity; relevant to thermal insulation.

Earlier work on dense ceramics has shown that a thermal resistance of the order of 1×10^{-8} m^2KW^{-1} can be attributed to the grain boundary. Smaller grain size thus decreases significantly the solid phase thermal conductivity in oxides like alumina and tin oxide. At the macroscopic scale, a tool box of analytical relations is proposed to describe the effective thermal conductivity of the porous ceramic as a function of solid phase thermal conductivity, pore thermal conductivity and pore volume fraction (v_p). For $v_p < 0.65$, the Maxwell-Eucken relation for closed porosity and Landauer relation for open porosity give good agreement to measurements on tin oxide, alumina and zirconia. For $v_p > 0.65$, the room temperature thermal conductivity of kaolin based foams and silica aerogels can be described by analytical relations based on closed/open cells depending on the pore connectivity. At higher temperatures radiation heat transfer should be taken into account. The study illustrates the important heat transfer mechanisms operating in thermal insulation.

As a second case, the thermophysical behavior of green bodies during heat treatment (firing) is examined. The starting pore volume fraction is typically 45-50%. Heat capacity, thermal conductivity and thermal diffusivity are important thermophysical characteristics for a green ceramic body which determine its thermal response and the energy exchanges during processes such as drying or firing. However significant variations in these characteristics can occur due to the evolution of the microstructure and any transformations of the solid phases during the process. Experimental thermal conductivity/resistivity data for alumina, tin oxide and kaolin clay are presented.