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# Intercomparison of thermal conductivity measurements on a calcium silicate insulation material

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ABSTRACT

The determination of reliable thermal conductivity values of insulation materials at high temperatures is important for target-oriented material research, further improvement of products and quality management. However, there is a lack of reference materials for high temperature thermal conductivity measurements which are needed to ensure and improve good measurement practise. In order to investigate porous calcium silicate as reference material for temperatures up to 1100 K, the German Thermophysics Working Group within GEFTA initiated an intercomparison of thermal conductivity measurements on a commercially available calcium silicate insulation material with seven participating laboratories. Stationary and instationary measurement methods were used to determine the effective total thermal conductivity of the calcium silicate material in the temperature range from 300 K to 1100 K. The derived weighted mean value of the thermal conductivity increases from 0.0846 W $m^{-1}$ $K^{-1}$ at 300 K to 0.173 W $m^{-1}$ $K^{-1}$ at 1100 K. Within the same temperature interval the relative uncertainty increases from 3.5% to 7%. The investigated product is commercially available and it could be therefore used in the daily laboratory work as reference material for thermal conductivity measurements at high temperatures.



## 1. Introduction

The German Thermophysics Working Group within GEFTA initiates and conducts several intercomparisons in the field of thermophysical properties. The objectives of this research work are to enhance the reliability of thermophysical data and to improve measurement praxis of the participating laboratories. The working group is aware of the urgent need for a reference material with low thermal conductivity values at high temperatures up to 1000 K as many members are involved in thermal conductivity measurements on high temperature insulation materials. The thermal performance of these materials is directly correlated with the improvement of energy efficiency in many industrial applications. Thus, reliable thermal conductivity data are needed to allow a target-oriented improvement of energy efficiency.

Unfortunately, there is a lack of reference materials with low thermal conductivity values at high temperatures [1,2]. The material has to meet several conditions before it could be considered as reference material. It should be isotropic and homogeneous on a macroscopic scale to allow the use of a wide range of experimental techniques for the determination of thermal conductivity. The material should be also stiff and mechanically stable to allow easy preparation. It should be a material with a low thermal conductivity even at high temperatures. Finally, it should be easily available and inexpensive to allow laboratories easy access to this material. Insulation materials based on calcium silicate could fulfil more or less all mentioned requirements.

Therefore in the past the determination of the thermal conductivity of calcium silicate specimen were the topic of various researcher groups performing thermal conductivity measurements up to high temperatures with different methods: Schlegel concluded that the observed deviations were higher than expected from standards. The uncertainties depends not on the applied measurement method, which were guarded-hot-plate method and hot-wire method (parallel and cross array) [3]. Same methods were used by Lohmann et al. up to 1173 K which states also no influence of the applied measuring methods on the thermal conductivity values [4]. Martin et al. stated that in the case of anisotropic calcium silicate materials the used hot-wire apparatus yields higher thermal conductivity values as derived by the guarded hot plate apparatus [5]. The differences were 3–7% depending on the anisotropy of the material. In the mid-nineties different guarded hot plate and hot-wire apparatus of European laboratories were compared in an international intercomparison on the thermal conductivity of low

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