Hot Disk Upgrade with Physical Simulation

Determination of the Thermal Contact Resistance of an Interface Layer

Graduate

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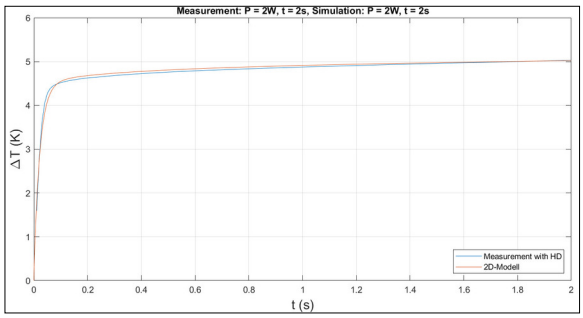
Problem: In numerous technical applications, interface layers form between contacting materials that significantly influence heat transfer. These layers act as thermal contact resistances and hinder efficient heat dissipation, for example in the cooling of electronic components. The direct experimental measurement of such resistances remains a major challenge. The aim of this work is the development of a validated simulation model that, in combination with the Hot Disk method, enables the indirect determination of thermal contact resistances.

Approach: To achieve this, the Hot Disk method was replicated in the COMSOL Multiphysics simulation environment. Experimental measurements were performed on boron nitride samples using the Hot Disk TPS 500. The simulation parameters were calibrated based on the measurement data. Subsequently, an interface layer was integrated into the virtual sample model to analyze its influence on the temperature evolution.

Result: The simulation with the interface layer shows that the temperature rise is increased compared to a homogeneous sample. This increase can be directly attributed to the thermal contact resistance caused by the interface layer. The results confirm the general suitability of the developed model for capturing such resistances. As a next step, a measurement method for the indirect determination of thermal contact resistance can be implemented on the basis of this simulation. Furthermore, the model provides the opportunity to systematically investigate different material combinations and geometries in order to optimize thermal contact quality. The combination of simulation and experimental validation represents a promising approach for the metrological determination of thermal contact resistances.

Comparison between Measurement and 2D Simulation Model
Own presentment



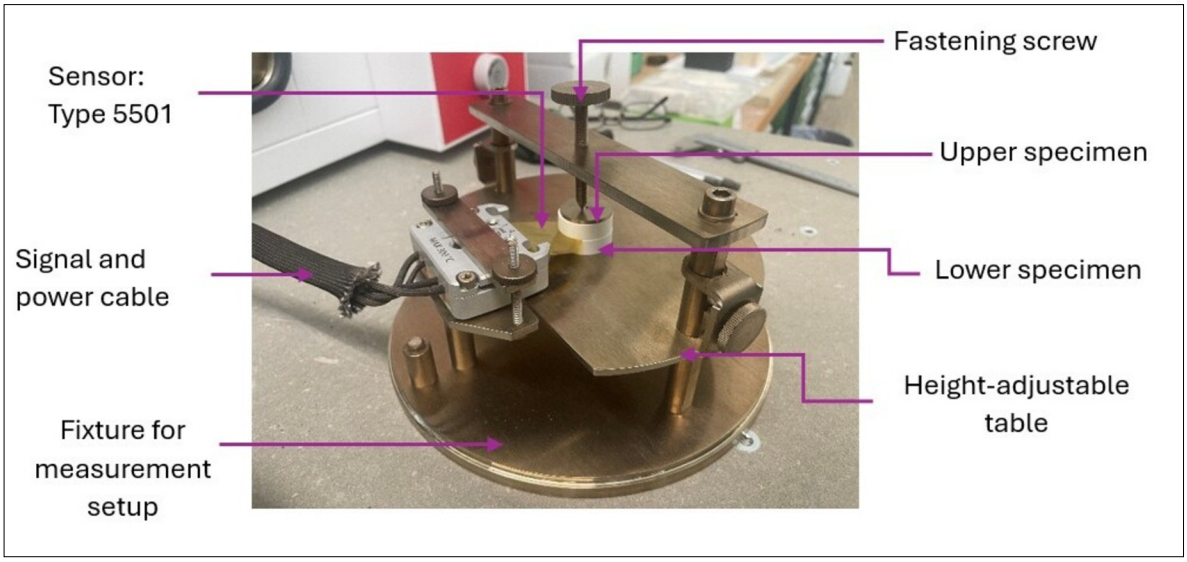
Derived Formula for the Experimental Determination of Thermal Contact Resistance
Own presentment

$$T(t) \approx T_{ref}(t) + \beta\, R_{crs}$$

$$R_{crs} \approx \frac{T(t) - T_{ref}(t)}{\beta} = \frac{\Delta T}{\beta}$$

$T(t)$	:	Temperature evolution with interfacial layer (K)
$T_{ref}(t)$	:	Reference temperature evolution without interfacial layer (K)
R_{CTS}	:	Thermal contact resistance of the interfacial layer ($\mathrm{m^2\,K\,W^{-1}}$)
β	:	Proportionality factor (approximately constant heat flux) ($\mathrm{W\,m^{-2}}$)
ΔT	:	Temperature offset ($T(t) - T_{ref}(t)$) (K)

Experimental Setup of the Hot Disk
Own presentment



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Subject Area
Computational Engineering