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Tackling thermal contacts between metal and glass – estimation and measurement

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Abstract
Evaluation of a precision system's thermal behaviour often requires understanding of the heat transfer though interfaces between components. The thermal interface resistance becomes more dominant for interfaces including a component with low thermal conductance and high surfaces hardness, such as glass, specifically when the contact pressure is low. Although estimations of thermal interface resistance are available in literature, the correlations for metal to ceramic contacts are limited. Thus, the goal of our study is to measure the thermal contact resistance of several metal to glass interfaces with small contact areas (e.g., line contacts) and small contact forces (i.e. about one newton). This paper presents the measurement approach and general conclusions from these measurements.

The measurement setup is a tower in a vacuum chamber to avoid heat transfer via the fluid in the gap. The measurement tower consists of a heater on the top, two tower parts from metal with the desired contact geometry and four temperature sensors, a glass disk in between the tower parts to avoid complexity in the glass component, and a cooling base to provide a constant temperature at the bottom. Consequently, the to-be-measured interface resistance is present twice. The measured transient temperature data is fitted to a lumped capacity model of the tower including heat radiation effects to obtain the measured thermal contact resistance.

The measurement tower provides repeatable results with an uncertainty band of ±40% on the measured thermal contact resistance for several metal to glass interfaces. The measured thermal contact resistance as function of the contact force shows a dependency with a power of approximately minus one-third, although estimations in literature suggest a power of minus one. In conclusion, the measurement tower can provide the interface parameters and understanding required to design future precision systems.

Thermal contact resistance, Thermal interface resistance, Thermal conductance measurement