ACTIVE HEAT-LOSS COMPENSATED MICRO-PIRANI GAUGE FOR VACUUM PACKAGES

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ABSTRACT

A Pirani vacuum gauge utilizes the fact that – between certain pressure limits – the heat transfer from a hot to a cold reservoir depends on the pressure of the gas between the reservoirs. However, since heat is not only transported by the residual gas but can also be dissipated via parasitic paths like radiation or through the suspensions of the heated element, the dynamic range of the measurement signal is limited [1]. There are several passive approaches to reduce the parasitic contribution such as a size-reduction of the suspensions [2] or coatings with materials of low emissivity [3]. In this work, we focus on an active heat loss compensation mechanism by introducing additional heating elements located at the suspensions to reduce parasitic heat transport considerably [4].
The Pirani gauge is fabricated by micromachining techniques as a micro-hotplate geometry (see Fig. 1a). Whilst the sensor element itself is operated at constant temperature (CT) mode, the suspension heaters are operated at constant power. The constant power level is determined at zero pressure and kept constant over the entire pressure regime. Since the heat loss via the suspensions is not a pressure-dependent quantity, this procedure enables an active heat loss compensation via the suspensions.
The thermal conductance, which serves as the measuring quantity of the system, can be calculated from the temperature difference of the sensor element to the ambient and from the power necessary to maintain this temperature difference. As can be seen in Fig. 1b, the thermal conductance is significantly reduced when operating the Pirani with heated suspensions. This leads to an enlargement of the dynamic range of the setup and can increase the measurement range towards lower pressures which is an essential requirement for any setup using an encapsulated vacuum package like miniaturized field emission sources.

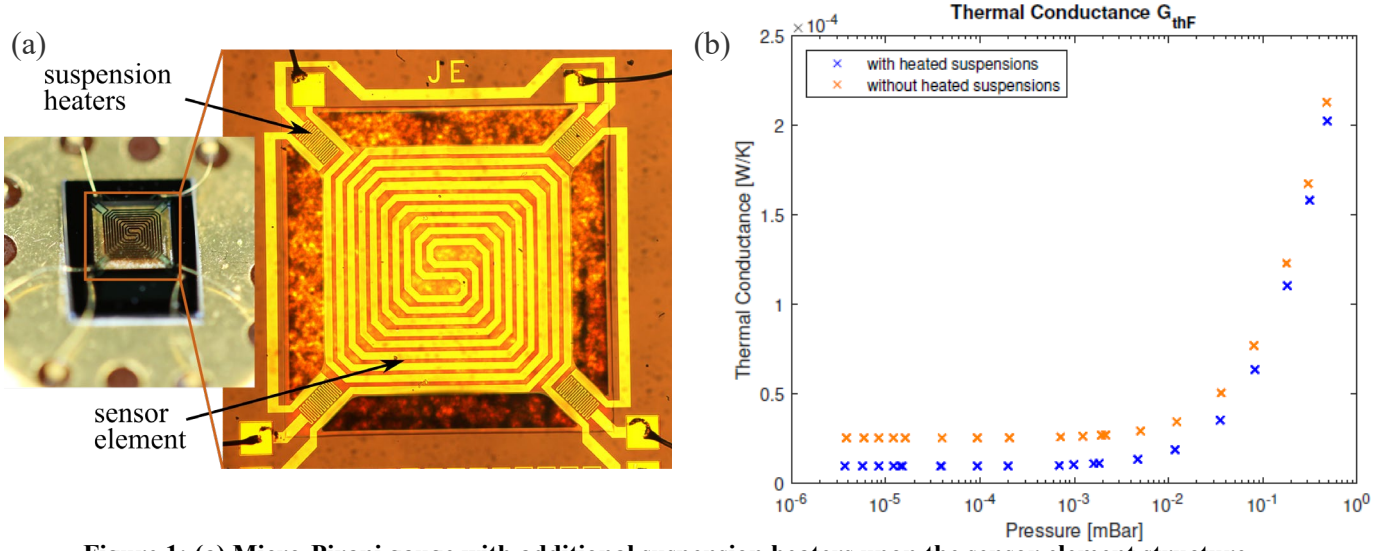

Figure 1: (a) Micro-Pirani gauge with additional suspension heaters upon the sensor element structure (b) Thermal conductance can be increased significantly by using heated suspensions

References

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