Study on Calibration Method of MEMS Heat Flux Sensor for Engine Use Including DC and Low Frequency Component

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Wall heat flux measurement is important to understand the flame wall interaction in internal combustion engines for the improvement of their efficiency. Thus, there is a need to develop a heat flux sensor enabling high speed measurement applicable to the engine. In our study, high speed MEMS heat flux sensors using thin film RTD deposited on the metal substrate of φ10 mm aluminum alloy with M10 screws have been developed for engine use. The heat flux is calculated by transient heat conduction analysis using the measured surface temperature, the geometry and the thermophysical properties of the sensor. In our previous research, heat flux sensors for 10 kHz high-speed phenomena and sub-mm scale spatial resolution have been developed. The proposed sensor can be calibrated for high-frequency (10 Hz~10 kHz) heat flux by the self-heating of the surface RTD. It was performed by adjusting the interfacial resistance between the thin film and the substrate in the analysis model. On the other hand, there was a difficulty in calibration of the low-frequency and DC heat flux because the boundary of the backside and edge of the substrate is required to be considered in the analysis model. Though, low-frequency and DC heat flux is important in the quantification of heat loss in general mechanical products, including engines. Therefore, a MEMS heat flux sensor measuring surface and internal temperature was fabricated. The temperature was measured by thin film RTD and commercially available Pt100, respectively. For the calibration of the DC and low-frequency component, the heat flux applied by the radiative heat flux on the top surface is introduced, and the thermal resistance and the thermal capacity between the internal temperature measurement point and substrate is estimated for the calibration. In this report, the validation of the proposed calibration method using the heater added on the sensor surface is discussed.