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Microscale thermal biosensor: Critical design considerations and optimization

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Calorimetric biosensors have been used for detecting various bioprocesses such as enzyme-substrate activity, protein binding activity, DNA reactions and cell metabolism. The majority of the microcalorimeter applications were proof-of-concept in nature, but having a strong potential for development for actual clinical, scientific, or commercial need. Success of these emerging experimental methodologies will be determined by such factors as the sensitivity and speed of these analyses when compared with existing technologies. These performance metrics are fundamentally related to the thermal transport through the microsystems. In this study, we present the design and fabrication of a microcalorimeter. We also characterize the impact of flow velocity affecting the thermal time constant of the microcalorimeter, steady state response of the system, and the location of the sensor in the flow stream and provide essential guidelines for the optimization of single-stream thermopile systems. The calorimeter consists of a 100 μm Y-shaped channel microfluidic device, which is made by sandwiching a microscope glass slide, Kapton tape cut in the form of channel and a microscope glass coverslip, and a bismuth (Bi)- antimony (Sb) thin film thermopile integrated on the outer wall of the microscope glass coverslip. The thermopile has a Seebeck coefficient of 5.95 mV/K. The performance of the microcalorimeter was characterized by measuring the heat released during the mixing reaction between water and ethanol. The ratio of flow rates is adjusted to change the location of the reaction zone relative to the measuring or reference junctions of the thermopile. Results indicate as the flow velocity increases the time constant to reach steady state response is decreased.

Biography

Varun Kopparthy is currently pursuing PhD in Biomedical Engineering at Louisiana Tech University. He has a Master's degree in Biomedical Engineering from Louisiana Tech University and Undergraduate degree in Biomedical Engineering from Jawaharlal Technological University, India. His research interests include lab-on-chip devices, MEMS sensors and biomicrofluidics.

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