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A Two-Color Fluorescent Thermometry Technique for Microfluidic Systems V.K. NATRAJAN, K.T. CHRISTENSEN, University of Illinois — The feasibility of implementing a two-color laser-induced fluorescence (LIF) technique to study thermal transport at the microscale is investigated. A temperature-sensitive fluorescent dye (Rhodamine B) and a temperature-insensitive fluorescent dye (Sulforhodamine-101) are used in tandem to determine fluid temperature with high accuracy and low noise using a pulsed Nd:YAG laser as an illumination source. While the fluorescence intensity of the temperature-sensitive dye is proportional to temperature, it is also biased by variations in the illuminating intensity. Therefore, a second temperature-insensitive dye is utilized in order to compensate for such biases. Calibration of the two-color LIF system reveals that the two-dye mixture in water yields a temperature sensitivity of 2.7%/K with volumetric illumination from the pulsed Nd:YAG laser. Additionally, the feasibility of this methodology for conducting temperature measurements is explored by measuring a steady-state temperature gradient generated across a microfluidic channel array by two large hot and cold reservoirs. These measurements yielded mean steady-state temperatures in the microchannels within $\pm 0.3\,^\circ$C of the predicted temperatures, with experimental uncertainties in the range $\pm 0.48\,^\circ$C to $\pm 0.56\,^\circ$C. Finally, this technique is applied to study the thermal transport characteristics of laminar and transitional flow within a heated rectangular copper microchannel.

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