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VISUALIZATION OF TEMPERATURE DISTRIBUTIONS IN MICROCHANNELS USING FLUORESCENCE POLARIZATION IMAGING

A. Suzuki, C.-H. Hsu, K. Tatsumi, *R. Kuriyama and K. Nakabe

Department of Mechanical Engineering and Science, Kyoto University
Kyotodaigaku-katsura, Nishikyo-ku, Kyoto 615-8540 Japan
*kuriyama@me.kyoto-u.ac.jp

ABSTRACT

This study describes the development of a non-contact and two-dimensional temperature measurement technique which exploits the fluorescence polarization microscopy[1]. When randomly oriented fluorophores are irradiated by a linearly-polarized excitation light, only those with the absorption dipole moments aligned parallel to the excitation polarization direction can absorb the light. If the excited fluorophores are free to rotate, the emission dipole moments, which are initially oriented along the absorption moments, are randomized due to the Brownian motion. Depolarization of fluorescence is therefore observed with the degree influenced by the extent of their rotation which is related to the fluid temperature, viscosity, and the molecular size. The major advantage of the present method is that it is less susceptible to the spatio-temporal change in fluorescent intensity caused by pH quenching and the non-uniformity in dye concentration or excitation intensity, compared to the methods based on fluorescence intensity measurement. The relationship between the fluid temperature and the fluorescent polarization degree (P) was experimentally obtained using casein molecules labeled with fluorescein isothiocyanate (Figure 1(*a*)). The result showed a reasonable trend that the reciprocal of P linearly increased with temperature in the range 28–38 °C. By applying this calibration line, two-dimensional distributions of P were converted into temperature distributions. A temperature gradient was clearly visualized in a straight microchannel in which a linear temperature distribution was generated (Figure 1(*b*)). These results confirm the potential of the present technique for contributing to the analysis and control of biochemical processes in microfluidic systems.

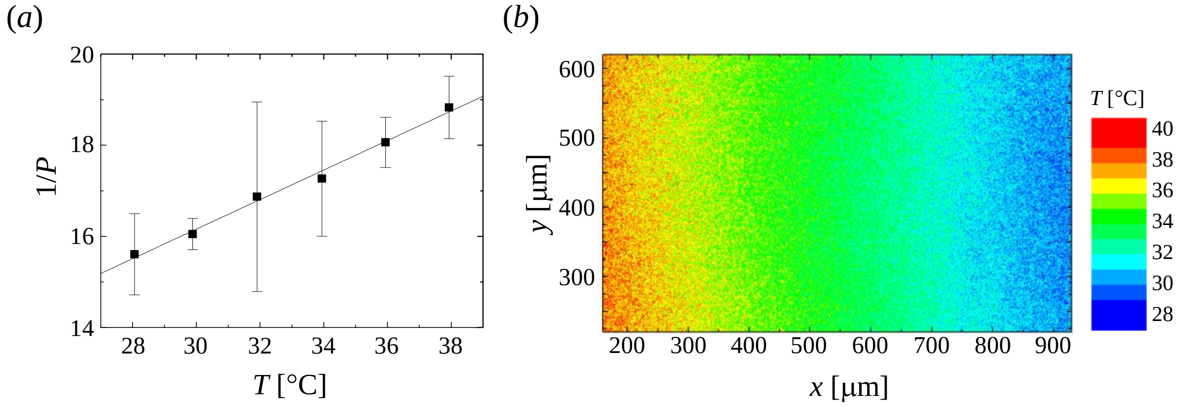

Fig. 1 (*a*) Calibration result and (*b*) temperature distribution measured in microchannel.

REFERENCES

[1] D. M. Jameson and J. A. Ross, "Fluorescence Polarization Anisotropy in Diagnostics and Imaging", Chem. Rev., Vol. 110, pp. 2685–2708, (2010).