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Summary

A fluorescent micro-optofluidic temperature sensor is developed using a temperature sensitive dye. The sensor can measure temperatures in microregions up to 70 ºC and is applicable in lab-on-a chip devices. It is fabricated using soft lithography method and uses Rhodamine B dissolved in water as a temperature indicator.

Introduction

Temperature measurement is an important issue in almost all fields of physics, chemistry and biology. Recent developments in the field of micro-electro mechanical systems (MEMS) have increased the interest of miniaturized optical sensors with additional system functionalities. The increasing use of a polymer called poly (dimethylsiloxane) (PDMS) in microfluidic device fabrication has made the temperature measurement prominent due to the low thermal conductivity. Polymer fabrication techniques [1] [2] of integrating optical elements into microfluidic devices have several advantages in terms of simplicity and cost reduction [3]. One of the optical sensor platforms is based on molecular fluorescence. An aqueous solution of Rhodamine B dye exhibits an inverse dependency of its fluorescence intensity on temperature [4] [5].
In this work a polymer based approach is used to fabricate microfluidic channels in PDMS with SU8 as a patterning layer. Optical fibers are integrated into the channel for coupling-in and –out of light. A laser (Thorlabs) operating at 532 nm wavelength and at a maximum power of 4.5 mW is used as an excitation source and a spectrometer (Torus, Ocean Optics) is used to collect the emission intensity. Figure 1(a) shows the image of a fabricated device and figure 1(b) demonstrates the excitation and emission of Rhodamine B.

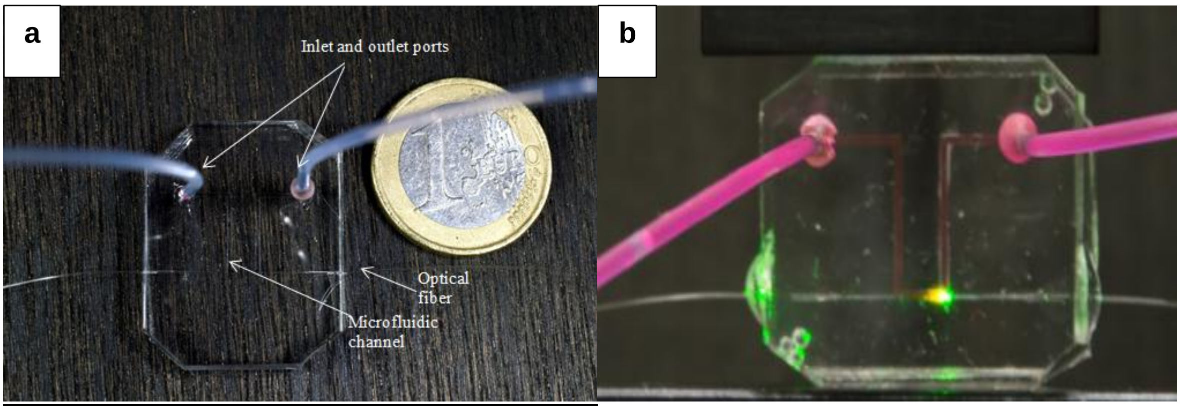

Fig. 1(a) Image of a microchip with integrated optical fiber and fig. 1(b) image of a device showing fluorescence of Rhodamine B

Discussion

An aqueous solution of Rhodamine B is prepared with a concentration of 1mM and used for the temperature measurement in this experiment. The chip is placed on a hot plate and a thermocouple (K type) is inserted in the chip. The liquid is preheated in a glass syringe to heat the solution before it is injected into the microchannel. In this way the absolute temperature difference between liquid and the device is reduced and the temperature can be adequately prescribed. The fluorescence intensity decay is linear. In order to verify the effect of Rhodamine B adsorption into the PDMS channel which ultimately affects the temperature measurement, a glass capillary channel similar to the PDMS chip is made and the experiments are repeated in the similar fashion. The temperature dependency in this case is also linear. Finally, error analysis is done and the results of the PDMS chip and the glass capillary is compared. It is noted from the results that the adsorption of Rhodamine B into the PDMS channel does not affect the temperature much because of the continuous replenishment of the solution into the microchannel.

Conclusions

A micro-optofluidic temperature sensor with integrated fiber is fabricated using a soft lithography technique. An aqueous solution of Rhodamine B is used as a temperature index. The experiment is conducted on PDMS and glass capillary. The results are compared and show a linear decay in fluorescence intensity as a function of temperature. It is a promising approach for application in lab-on-a-chip devices.

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